Automotive News®

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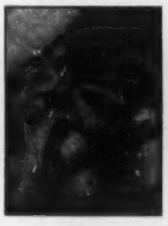

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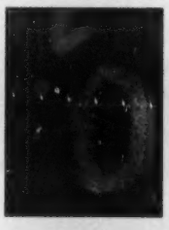

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Technology teasers for 2000

U-M's Delphi V panel tries to predict inroads in coming decade

For American car technology over the next 10 years, future shock may turn out to be more a gentle buzz. At least, that's how the 330-member panel of Delphi V sees it.

In a way that's not too surprising. After all, the industry has just gone through a revolution, and after all revolutions comes a period of consolidating gains. And the Delphi panel members, the collective opinions which make up the University of Michigan technology forecast, expect the next decade to be just such a period. The American automobile will continue to change, they say, but the rate of change will be more evolutionary than revolutionary.

The mainstream American car of 2000, they predict, will be a front-engine, front-drive, steel unibody, gasoline-powered, ABS-equipped sedan, slightly larger but also slightly lighter than its 1990 counterpart.

Under that familiar skin there will be substantial changes — including more sophisticated suspensions, the use of now-exotic materials like ceramics and higher electronic content. But even in these areas the rate of change will be considerably slower than in the decade now ending, and, interestingly, quite a bit slower than was anticipated by panels in previous Delphi studies, which contemplated much more radical change by the end of the century.

That's likely because each of the Delphi studies (Delphi I in 1979, II in 1981, III in 1984 and IV in 1987) were done in (automotively speaking) turbulent times, when car sizes were being slashed and engines were losing cylinders faster than the UAW was losing membership and the domestics were losing market share. Both of the latter only adding to the froth.

Each Delphi study, as the editors of the 1989 version are quick to state, "is a snapshot that collects and presents the opinions and attitudes of a group of experts at that particular point in time." And clearly the attitudes of the experts have changed.

If, a decade ago, there was still strong talk about "throwing the imports back into the sea," today the prevailing feeling might better be characterized as "we have met the enemy, and it is us."

One thing that has not changed is the experts' belief in the need for quality. It remains number one in importance. What has changed, however, is the idea that quality can be a competitive advantage; that's been replaced by the reality that quality — and value — have become such basic issues that you need a carload of both to survive in the market.

"True and total customer satisfaction," the experts say, is the key to the next decade. Technology for technology's sake is history. Such goodies as CRTs, head-up displays and active suspensions, they say, will have only a tiny role, if any. The increased emphasis, in an ever more competitive market, will be on real and perceived value. Technology will be important in terms of competitive edge, but only if it meets customer expectations at a reasonable price.

That's a quick view of Delphi V, the future of automotive technology as seen by 330 executives, engineers and academic/consulting specialists (57 percent from vehicle manufacturers, 32 percent components and parts suppliers and 11 percent outside specialists, consultants and academics). Here are their thoughts on the making of the American car, circa 2000.

Author Bill Lovell is a freelance automotive reporter.

General issues

Fuel and fuel economy: One important reason behind the conservative forecast is a widespread belief that fuel prices will remain stable over the next decade. Panelists predict the price of unleaded regular gasoline will rise only to $1.40 a gallon (in 1988 dollars) by 2000, much less than the price foreseen in previous studies (Delphi I, by contrast, forecasted a price of $2.50 a gallon, in 1979 dollars, which translates to $4.07 a gallon today).

The present optimism on fuel prices is based on several factors: 1) Even with war in the Middle East, real energy prices actually have dropped. 2) Increased appetite for cash in the energy producing countries will require the sale of increasingly larger amounts of crude. 3) Progress in alternative fuel technology is causing those countries to rethink basic policies; they fear that any disruption of supply will only accelerate the move toward alternative fuels. 4) Continued improvement in overall fleet fuel economy and 5) Increased worldwide political stability as the communist countries move toward market-oriented economies.

Of course, the panelists keep in mind the possibility that the Middle East market could crumble, making all these predictions seem as silly, in retrospect, as "Dewey Beats Truman." If that happens, all bets are off — including most of the forecasts of vehicle size.

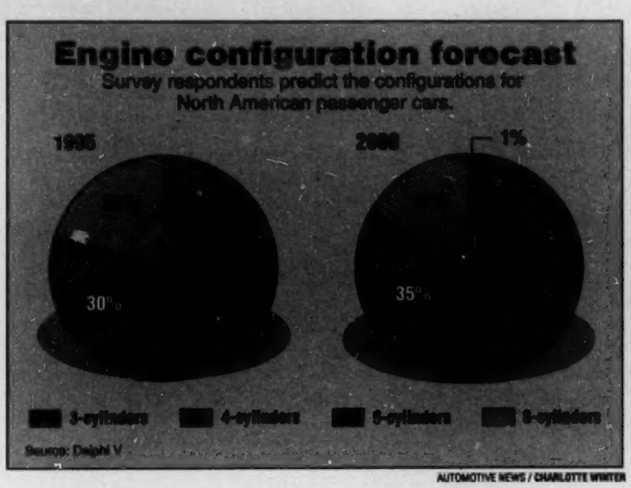
Panelists do think there will be a slight movement toward "flexible fuel vehicles," with 10 percent of the fleet able to use a full range of methanol-gasoline blends by 2000. Panelists think the actual number will depend on three factors: government regulations, world energy conditions, and the success of direct-injection technology in solving current cold-start problems.

Improvements in fuel economy, panelists believe, will come primarily from improved powertrain efficiency, and to a lesser degree from weight reduction, aerodynamics and improved accessory drives. The age of downsizing, on the other hand, is over; panelists believe only 5 percent of future improvements will come from size reduction — and some panelists bluntly say that cars will, in general, become larger.

Competitive factors

No surprises here. For a manufacturer to be competitive in the years ahead, panelists say, it has to be strong in two key areas: Quality and cost. Third, fourth and fifth will be: New technology/product innovation, styling and responsiveness to market (i.e., the time it takes to bring a new car to the showroom).

There is a strong consensus, somewhat ironically, that while quality and cost will become even more important over the next decade, both will effectively disappear as reasons for customers to choose one car over another. They will become so important, panelists believe, that they will become basic requirements for staying in the market, and the surviving manufacturers by 2000 will have essentially achieved parity in these areas. This development will leave new technology (but only where it is perceived by the customer as real value) and styling as the areas in which one manufacturer can grab an edge.



AUTOMOTIVE NEWS / CHARLOTTE WINTER

One phrase expected to become common over the next decade is "life-cycle management," meaning active involvement with the customer even after the warranty is up. The factory-to-customer relationship is expected to move closer to "cradle to the grave," beginning in the showroom and ending with recycling the worn-out product.

To this end, panelists predict improvement and expansion of onboard self-service/diagnostic systems, including the development of artificial intelligence systems for dealerships. Powertrain warranties, meanwhile, are expected to expand to a period of from 8-10 years or 100,000 miles.

All of these developments will keep the customer tied to the dealer longer, making it tough for the independent repair facility.

Government regulation

Panelists expect increased activity in this area — almost a given after the years of relative inactivity during the Reagan administration. They are almost unanimous in expecting more standards in the light truck area, including occupant restraints, vehicle emissions and crashworthiness, but they also forecast tougher occupant safety and emissions standards for passenger cars as well (it should be noted that the study far preceded the recently suggested emissions standards in the Congress). Over 60 percent also believe state "lemon laws" will become more prevalent in the coming decade, while they are almost evenly split on the question of product liability, with about half expecting a federal limit on product liability awards and another half predicting an increase in this area. Electronics and braking systems were the areas most cited for new product liability activity.

Some areas seen by panelists for possible new regulatory action include noise standards (for tires as well as cars) and brakes, with many panelists foreseeing mandatory anti-lock braking by the end of the decade. Most panelists, in fact, see ABS becoming the standard, through market pressure if not governmental regulation.

As for proposed amendments to the Clean Air act, panelists see improved integrated and computerized adaptive engine controls and new fuel injection controls to be the key technologies. Less than a third, meanwhile, see improved catalyst systems as a major factor.

Vehicle development

Panelists expect the current gap between domestic and Japanese lead-times for new products to shrink dramatically, if not actually disappear. For reskinning an existing platform, the gap is expected to shrink from the currently estimated 13 months to five, for a completely new vehicle from an estimated 18 months to eight. Of course, the gap is a moving target.

Panelists estimate that current lead-time for a Japanese manufacturer to develop a completely new vehicle is 42 months. By 2000, panelists think it will take an American manufacturer 40 months to accomplish the same task, while the Japanese will require 32.

Many panelists believe that management, not technology, is the major stumbling block in this area. To quote the study directly, "there is growing consensus that project teams with multidisciplinary membership and a strong leader together with a minimum of interference from top management is very helpful in streamlining the process."

Two technical factors are expected to play important roles in reducing vehicle development time: development of "comprehensive internal engineering data bases and an appropriate network to interface with them;" and increased use of analytical tools, such as computer-generated simulations and models, in place of traditional test and development techniques.

An additional factor is expected to be the stockpiling of technology, validating it and putting it "on the shelf" before it is used in new programs. This, the study says, will be more time-effective than the current domestic practice of inventing new technology during the product development process.

Reflecting both the globalization of the industry and the drop in the number of American engineering students, panelists expect more product design and engineering will be performed offshore. They estimate that 15 percent of such work is now performed overseas; that estimate rises to 25 percent by 2000.

CAR ENGINE FEATURE FORECAST

Engine features	1995	2000
Fast-burn combustion chamber	65%	80%
Knock-limiting devices	30	60
Roller valve lifters	40	60
Distributorless ignition	40	75
Four-valve combustion chamber	15	30

SOURCE: Delphi V

CAR ELECTRONIC FEATURE FORECAST

Electronic features	1995	2000
Electronic transmission	30%	75%
Multiplexing	7	20
Navigation/information	3	8
Variable valve timing	5	10
Drive-by-wire	1	5

SOURCE: Delphi V

Evening things out somewhat, panelists expect Japanese manufacturers in the U.S. to make greater use of American talent in these areas. At the same time, they predict that outsourcing of components by U.S. companies will rise slightly, while Japanese companies will increasingly utilize American parts.

Body and Chassis

Unibody construction will continue to be dominant, with panelists predicting that 92 percent of North American-built cars will be of the integral body/frame type at the turn of the century.

They forecast a slight drop-off in separate body/frame vehicles — down to 4 percent, and a modest rise in space frames, *a la* the new GM minivans, also 4 percent of the market. There are those who think the space frame percentage may be higher, depending on new metal bending and welding technology, but most believe the unibody will continue to be the winner in terms of ease of manufacture, cost and safety/regulatory considerations.

Panelists forecast an average curb weight of 3,032 pounds for domestic cars by 1995, and believe that figure will drop only slightly by 2000, to an average of 2,943 pounds. They foresee only a slight drop in the amount of steel in each car — to 1,560 pounds by 2000 — a drop in cast iron, and modest increases in the use of aluminum and plastics. Interestingly, these overall weight estimates are the highest ever made by any Delphi panel, representing a renewed appreciation for traditional technologies.

MacPherson strut front suspension will drop somewhat in popularity but continue to be the system of choice on 75 percent of domestic cars by 2000, while panelists forecast a slight gain for twin A-arms, up to 25 percent. They see a major shift to independent rear suspension— with 60 percent having four wheel independent suspension by 2000. Few expect electronically controlled active or passive suspension systems to make much of an impact, except on expensive specialty cars. For the mainstream car, they see conventional shocks and steel springs continuing to dominate the market.

Also limited to the high end of the market will be such technologies as electrical/electronic power steering and four-wheel-steering. Such developments, panelists say, are too costly and provide too little ▶

benefit for the dollar to make much of a dent in the mainstream market.

Interestingly, panelists are enthusiastic over the future of antilock brakes, but somewhat less so concerning rear-wheel discs. They think the percentage of domestic cars equipped with four-wheel disc brakes will increase to only 20 percent by 2000 (5 percent each for light trucks and vans), while forecasting that 70 percent of domestic vehicles will have ABS by the same time. They also expect 15 percent to have some sort of traction-control (anti-spin) system by the end of the '90s.

Sixty-three percent of the panelists believe that ABS will become a federal requirement for passenger cars by 1998 — and many who do not think that market pressure will make such regulatory action unnecessary. Clearly, ABS is one technology that the panelists expect will be a huge hit with consumers.

One thing the panelists say is a real dud is the idea of no spare tire. While Delphi I predicted that 50 percent of 1990 cars would be spareless, Delphi V recognizes that the public wants the security of a spare, regardless of advances in tire technology.

In 2000, panelists predict, 10 percent of domestic cars will carry standard spares, 80 percent mini-spares and 10 percent no spares.

Panelists are likewise conservative when it comes to tire features. They expect 30 percent of domestic cars to come equipped with puncture-resistant tires, but just 12 percent "self-sealing" and zero percent "run flat."

Inside the cabin, panelists predict that "conventional" instrument panels and stalk-mounted controls will each lose ground, the former by a considerable extent, the latter only slightly. The use of pods is expected to rise slightly, as are steering hub controls, but the latter will depend on the percentage of cars with air bags. "Some combination of above" is the consensus choice.

Look for better seats, with more emphasis on function than appearance. Panelists look for more multi-adjustable seats, many with electronic memory.

Controls, they say, will be more accessible, perhaps more adjustable, use more electronics, simpler and more functional. Vacuum fluorescent displays will continue to be strong, but multicolor liquid crystal displays are expected to be equally strong by 2000. Cathode ray tubes, as seen on some Buicks the last few years, are not expected to have much of a future.

Panelists expect both passive-belt restraint systems and air bags to be strong by 2000, with air bags the ascendent technology. Eighty percent of domestic cars, meanwhile, will feature rear-seat shoulder restraints (69 percent of the panelists believing such restraints will be legislatively mandated).

On the subject of "friendly" interiors there was deep division among the panelists, but 72 percent thought that such impact-absorbent interiors would provide useful supplementary crash protection. The trend here seems to be toward smoother, less intrusive interior design.

Powertrain/Drivetrain

Aluminum is expected to continue its growth as an engine material, with panelists predicting that 70 percent of engines will have aluminum cylinder heads by 2000. We will also see more aluminum blocks, but only in 12 percent of all domestic engines.

Polymer-based engine components will also grow in popularity, but only in non-moving parts like intake manifolds, oil pans and valve covers. The use of ceramics is also projected to grow, from almost nothing today to as many as 15 percent of 2000 engines, particularly in areas such as valve train components, exhaust manifolds, turbochargers and seals.

Panelists expect the mix among four, six and eight-cylinder engines will remain relatively stable over the next decade, as will engine displacements. Pushrod engines will fade in popularity, they say, while single and double-overhead cam designs will together take over the majority of the market. Multi-valve engines will continue to increase, while 2-valve per cylinder designs will drop to 60 percent. In the valvetrain itself, there will be some movement toward variable timing control and variable lift control, but mainstream use of such technologies is probably more than a decade away.

It is anticipated, overall, that there will be large-scale fundamental redesign in the engine area. Here Delphi V is more optimistic than Delphi IV; 60 to 70 percent of the panelists believe that American engines, now relatively old in design compared to foreign competition, will see fundamental changes in the coming decade.

The panel does not, however, see a great swing toward two-cycle engines: it sees only 2 percent penetration by 2000, 5 percent by 2005. Nor do panelists see any movement toward diesels; only in light trucks do they see any market at all. Likewise, such alternative engine types as stratified charge, rotaries and turbines are seen as having a tiny impact, if any.

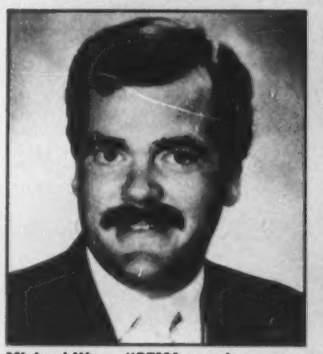
Technical features that do look promising include fast-burn combustion chambers and roller lifters, both of which are expected on the majority of engines by 2000. Other features expected to grow in popularity include balance shafts (on four-cylinder engines), lean-burn technology, powdered metal cams and gears and hollow camshafts. Expected to remain static, at best, are two of today's most-touted features: turbochargers and superchargers, neither of which is expected to be in more than 5 percent of domestic engines by 2000.

Other engine technologies expected to grow over the next 10 years include knock control, distributorless ignition, individual cylinder control of ignition, closed-loop timing and coil-on-plug ignition. Multi-point fuel injection is expected to be the dominant fuel management system, with 75 percent of the market by 2000. Throttle body injection gets the other 25 percent; the carburetor gets an epitaph.

As for driveline configuration, panelists expect front-engine, front-drive to become even more dominant, with 80 percent of the domestic market by 2000. Front-engine, rear-drive, they say, will drop to less than 15 percent, while all-wheel drive will account for 5 percent. Eighty-seven percent of domestic cars will have automatic transmissions, with four-speeds the most common. Continuously variable transmissions will have some impact, though CVTs are expected on no more than 3 percent of 2000 cars. Electronic transmission control is one technology expected to grow rapidly; panelists expect 30 percent of 1995s transmissions to be so-equipped, and fully 75 percent of 2000s. Lock-up torque converters, panelists say, will become almost standard equipment, with 90 percent penetration by 1999. ■

Adding a personal touch

Individualism renews growth in specialty products aftermarket



Michael Warn: "SEMA members are confident growth will occur."

Readers of Automotive News are probably familiar with SEMA and the companies represented by the association, since the SEMA membership is made up of manufacturers, distributors and retailers of specialty and performance equipment found on all cars, old and new alike.

In fact, the nation's automobile and truck dealers themselves, no doubt deal periodically with SEMA-member companies in efforts to embellish their showroom products with specialty gear to add that extra appeal as a customer draw. And therein lies the prognosis for specialty products.

Changes to products in the specialty and performance segment of the automotive aftermarket are often in parallel to those — sometimes subtle, sometimes dramatic — evident in new-car offerings. In many cases the changes are the result of technological progress; but they are often in response to trends from the buying public.

Suffice to say there are more changes to new vehicles as a result of technological developments, while specialty products (accessories) are designed and meet with favor among consumers because of prevailing or impending trends. Specialty products enable the car owner to make changes according to his preferences quicker than if he were to wait for a new car as a result of the model changeover.

By the most simple definition, specialty products are those which enable the car owner to personalize. In the history of our industry segment, the trends and products marketed to satisfy the consumers' demands came about as a result of two specific (basic) hobbyist activities: customizing and racing.

Customizing, and the techniques to redesign cars, has its roots in custom car shows and similar enthusiast get-togethers. Aficionados are responsible for myriad innovative characteristics to a car's appearance.

Today customizing has been all but replaced with terminology that more accurately reflects the broader base of consumer interest: personalizing and individualism.

To refashion a car's appearance or uses, applying specialty merchandise produced by our industry, is to personalize it, to make it a reflection of the owner's intent to have something uniquely different when compared with vehicles of his peers. It is an expression of individualism which some refer to as a form of automotive art. Motorsports, and specifically racing, on the other hand, have made their own contributions to the progress of the automobile, and in virtually all walks of the activity. There is no better testbed than the race track, a factor proven throughout the years.

Today, motorsports activities in vertical forms, such as off-road racing, enable suppliers of light- and medium-truck products a testbed similar to what auto racing has done for the modern car. Hot rodding, in which the specialty and performance products industry has its roots, is a diverse activity which not only represents a substantial piece of the product sales-volume pie, but has over the years offered certain innovative developments of value to the motoring world at large. Of importance to U.S. automobile manufacturers is the R&D achieved test results, usually the product of on-street or on-track testing which substantiates durability claims.

Specialty cars, personalized cars, all forms of racing and hot rodding have prospered through the years. More recently, there's been impressive growth throughout motorsports, and there is every indication it will continue into the 1990s and beyond, signaling even greater sales volumes for suppliers of both performance cars and aftermarket products. SEMA's forecasts are based on developments and research which reveal unprecedented growth. And there are events which clearly support the ambitious projections, among them the annual SEMA Show in Las Vegas.

Last year, the specialty products exposition achieved ranking as the flagship of automotive aftermarket trade shows, with nearly 3,000 exhibit booths occupied by more than 900 companies, and 14,000 buyers in attendance.

Thus as we enter the 1990s, we look not to guesstimate predictions, but rely instead on this aftermarket segment's recent history. Also watched is the trend among car owners and their relentless efforts to personalize cars to achieve individuality, as well as improve on the overall performance, including modifications to those vehicles described as showroom fresh.

In the past few years we've seen evidence of how a single segment of our industry can and does flourish as a result of consumer demands: ground effects systems which will no doubt grow in popularity and enjoy the attending sales volume in the '90s and beyond. It's a sales phenomenon.

Determination among consumers to improve the performance of vehicles is inevitable — always has been. As the industry segment develops and refines products — in many cases those in the electronics category — we'll see increased sales to those who seek improved performance, be it economy, improved operating efficiency or better handling. And the light-truck market, both new vehicles and accessories for them, needs no further explanation.

Changes will occur no doubt into and through the next decade. It's the nature of the specialty business to not only adjust product lines and the products themselves as enthusiasts' preferences reach beyond the status quo, but our industry responds to changes quickly — the SEMA members' advantage in this competitive arena.

Combine that edge with the R&D available from our industry to automakers, and the lower cost compared with their own, and it is clear the auto industry could — and should — look to our industry more often for product development. The doors of our manufacturers are open; the automakers will wisely benefit by walking through those doors to develop cooperative efforts and programs for the development of products and marketing strategies.

It is the opinion of many in our field that the new-car buyer, and the dealer serving that customer, will look to and deal with sectors of the specialty and performance aftermarket more in the future.

There is considerable evidence on the horizon, if not today: Manufacturers, domestic and import companies alike, have recognized and acknowledge the sales volume which awaits dealers not only in replacement parts, but in specialty equipment and accessories.

Will this development impact the distribution and retail segment of the specialty aftermarket? To some extent, yes, since the dealers have an opportunity to expand their sales to the growing number of performance-conscious customers. But the specialists, the hot rodders, currently serving the most sophisticated aficionados of performance, will maintain their positions as experts at the retail level, prepared to assist any car owner with customizing and performance-improvement guidance and products.

Performance products distributors (warehouses) will no doubt become sources to dealerships for product, either as fill-in suppliers or as regular sources for merchandise among dealers who choose not to invest in the substantial inventories needed to serve this growing bloc of customers.

The specialty and performance segment of the automotive aftermarket has thrived on change, for it is on trends this section of the industry is dependent — either those brought about by consumer demands, or those inspired by innovative developments from within the industry and can be traced to the hobbyist activities themselves, be it racing or customizing. But the 1990s will no doubt be looked upon as the decade of change, market segments included.

Changes though there may be, SEMA members are confident growth will occur, in keeping with industry history that's solidly founded on innovation and the ability to respond to trends. That, together with a renewed favor among motorists for individualism and improved performance in their personal cars, combine to support predictions that the 1990s loom as a boom decade for specialty and performance products. ■

Author Michael Warn is the CEO of Warn Industries and the chairman of the board of the Specialty Equipment Market Association.

Humanware

Interaction between man and machine will rise in the '90s

In the year 2000, drivers could have intellectual relationships with their cars, which would be intelligent machines capable of taking control when the driver makes a mistake.

According to Japanese researchers, technology will have evolved into what they call humanware, which puts an emphasis on the interaction between people and machines.

The researchers, with Mitsubishi Motor Corp.'s Technology Administration Department, are Sunao Chikamori, vice general manager; Arata Sumie, manager; and Yuzo Ohta, assistant manager. Their work was presented to fellow engineers during an SAE meeting in Dearborn, Mich., in September.

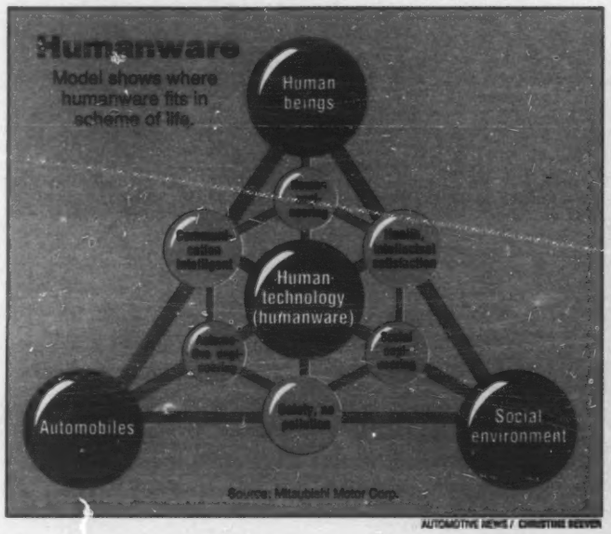
They contend that interest through the 1990s will shift to humanware and away from hardware and software. They say valid predictions of how autos will evolve toward the end of the century can be made only by considering cars as a part of social life.

They focused their work, therefore, not only on trends in automotive technologies but also on international, social and market environment changes.

Overall, world demand for cars is expected to grow mildly at an annual rate of about 1 percent, said the researchers. However, they said, excess production capacity will cause oversupply, leading to such measures for survival as more complicated linkups and cooperation among automakers in different countries. They foresee mutual agreements between manufacturers in advanced nations and an international division of labor among manufacturers in advanced and industrializing countries.

"Superior, unique technologies are even more vital for an automaker to maintain the independence and self-reliance in this severe and complicated situation of internationalization," they said. "These technologies must be developed in line with . . . user trends.

Author Roger Rowand is an Automotive News staff reporter.



AUTOMOTIVE NEWS / CHRISTINE BEEVER

Thus it is even more important to observe the direction and precisely grasp future trends in technologies."

Here are the major social environment changes the Mitsubishi people foresee as the year 2000 nears:

- A population trend toward aging is expected to grow after a slow start in Japan and continue in Western countries.
- Women's participation in the Japanese work place and in public affairs will continue to grow.
- Men and women will have more free time as the number of hours annually spent working dips from 2,200 to 1,800, and income will increase in Japan.
- A population segment of the New Rich may emerge, which may alter the Japanese tradition which holds hard work as a strong virtue.

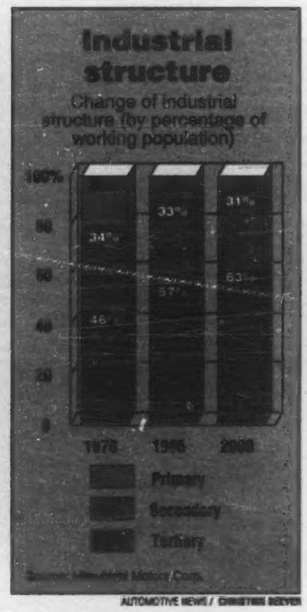
Based on those assumptions, the Mitsubishi researchers also predict large amounts of working time will be devoted to preparing for what they called worthwhile living into old age. That will involve home medical equipment, total asset management, private homes for the aged, residential meal service and personal pension and insurance plans.

Too, they said, participation in cultural and creative activities will increase, especially for housewives, because of day-care and household services.

There will be a major switch in consumption; people will seek more services and turn away from goods.

Physical distribution of goods in 2000 will require lightweight and compact products, not big, heavy trucks. The researchers predicted a continuing need for large-lot loads and long hauls, but they said the need for inexpensive, fast and safe small-lot loads, short hauls and door-to-door services will increase greatly because of changes in industrial structure and growth of non-store retailing.

The forecasters see a gradual international harmonization of laws and regulations covering exhaust emissions, fuel economy, noise and safety. Although other countries will emphasize various segments of the auto industry, Japan will hold the top position in production and



AUTOMOTIVE NEWS / CHRISTINE BEEVER

technology, predicted the researchers.

In engines and transmissions, current basic trends will continue but more emphasis will be placed on electronic precision and optimum control and new materials will be used, they said. Manual transmissions will retain a cost advantage over automatics but lose their fuel economy advantage as automatics are improved.

Toward 2000, critical body performance factors will be improved, including safety, rust prevention and aerodynamic characteristics, they said. However, they foresee no conspicuous change in shape. Although current basic structures will continue to be used, they foresee unit body structures that permit easy, automatic assembly, and custom-made structures that will suit particular needs of customers. Some body components will come with shapes that can be changed by the user.

The group also predicted composites will be used extensively and electronics will be put to work controlling more engines and transmissions. As 2000 nears, electronics that now are in their second generation will be in their third generation, involving integration and systemization.

In 2000, automotive computers will provide overall control of the vehicle. Major technology areas to develop in the decade to come will include:

- Ways to integrate overall control of a number of computers.
- Transmission techniques that allow a number of signals to be arranged and sent over single wires.
- Smart sensors with judgment and intelligence.
- Compact but powerful actuators.

Development of the materials of the future, is well under way in Japan and will produce results in the '90s, said the researchers.

Among the possibilities for automotive applications, they foresee composite materials used in gears, clutches, bumpers and pistons; high molecular weight materials used for springs, tires, oil pans, tanks and fans; and alloys that remember their shape and are directionally solidified.

Manufacturing trends will move toward ways of being profitable on small quantities of cars. "The future trend of production technologies is toward manufacturing systems that meet the ever-increasing diversification and individualization required of automobiles and fill the demand for made-to-order vehicles in addition to a higher degree of automation," said the group.

As components of that automation, they listed robots and computer-controlled laser-beam machining and electron-beam machining.

Parts and materials will come from a far wider international area. This trend is also true in design and production, they said, and internationalization of terminology can be expected.

Near the end of the 1990s, people will seek intellectual satisfaction, which will lead to the researchers' humanware. ■

Putting the brakes on car theft

1.4 million stolen in U.S. in '88; tops in the world

Experience by the National Automobile Theft Bureau — a non-profit corporation that monitors vehicle thefts — indicates there is increasing activity in international trafficking of stolen vehicles.

U.S. Customs estimates some 200,000 stolen vehicles may be illegally exported from the United States each year. These stolen vehicles are transported via air and water to Europe, the Middle East, the Caribbean nations and by land, sea and air to Central and South America.

The United States is not the only nation confronted with a growing vehicle crime dilemma. Reports from selected nations around the world indicate that the vehicle theft rate per 100,000 population, is higher in Scotland, England, Wales, Australia, France, Denmark and Sweden than it is in the United States.

The United States, however, continues to lead all nations in total number of vehicle thefts, with over 1.4 million last year.

Vehicle crime is by far the worst of the property crimes, which also include burglary, larceny-theft and arson. Although vehicle theft accounts for only 11 percent of total property crimes, it accounts for 48 percent of all property crime costs. Last year alone, vehicle theft costs were approximately $7 billion. What may be worse of all is that vehicle theft affects Americans twice. It costs first in property loss, time loss, inconvenience, insurance premiums, and most significantly in injuries and lost lives.

Second, it costs in tax dollars that go to maintain law enforcement activities, courts, prisons, and other agencies of vehicle crime control.

Author Paul W. Gilliland is president of the National Automobile Theft Bureau.

Criminal justice system

Car theft is considered a high-profit, low-risk crime that permits timely liquidation of the object of the crime with little chance of detection and identification. Vehicle theft, when compared with the more serious crimes against persons, is assigned a low priority by police.

During the last 10 years — while the crime has increased 44 percent — many law enforcement agencies experienced reductions both in manpower and in funding. There have been over a million thefts a year for the last five years.

Vehicle Security

Many of the previous vehicle security system designs — primarily directed at the resistance to force normally encountered in the smash-and-steal method of operation — were ineffective.

General Motors, for example, has been equipping all Corvettes, starting with 1986 models, with a Vehicle Anti-Theft System.

VATS, as the system is called by GM, uses computerized circuitry to identify the matching resistance of a pellet embedded in the ignition key in addition to the normal mechanical match of the key with the lock in order to start the car.

In 1985, before VATS was installed as standard equipment, 1985 Corvettes experienced a theft rate of 14.39 thefts per 1,000 vehicles. In 1986, after VATS was installed as standard equipment, the theft rate dropped to 10.94 thefts per 1,000 Corvettes manufactured during the year — a 24 percent decrease in the theft rate.

In 1987, the second year VATS was standard equipment, the theft rate for Corvettes dropped to 9.57 thefts per 1,000 vehicles, a further decrease of 12 percent.

Currently, General Motors installs a corresponding theft deterrent system, named Pass-Key, as standard equipment on both the Camaro and the Firebird.

Index tracks theft, fraud

The National Automobile Theft Bureau is a non-profit corporation established for the investigation, location and identification of stolen vehicles.

In the bureau's system, if a vehicle is stolen, the owner promptly reports the theft to law enforcement and then to his or her insurance company. The insurance company then reports the theft to the National Automobile Theft Bureau where it is automatically edited to determine the accuracy of the VIN.

The database is then searched for any record of previous history involving the vehicle.

If a vehicle identification number fails the bureau's search, the number is compared against a file containing over 240 million manufacturers' records of vehicle assembly and shipping information. ■

Retailing in the 1990s

Manufacturers continue to look for a competitive edge

Predicting the future is always a dicey business, especially during times of rapid change. But change at an accelerating rate is precisely what J.D. Power and Associates foresees for the automotive industry in the 1990s. Moreover, this change will come in all facets of the industry.

Case in point No. 1: automotive design. Our data show that American consumers believe that the gap in product quality is narrowing. As perceived product quality nears parity during the next decade, and as some of the other product differentiation criteria blur (With the advent of passenger minivans, what is the difference between a car and a truck?), automotive designers will be challenged to find new ways to make their products stand out.

Whiteside

One possible direction of change is a proliferation of niche vehicles, each tailored to a specific type of activity.

We saw this approach, for example, in a recent show of automotive design exercises by students at the Pasadena-based Art Center College of Design. In addition to the swooping, aerodynamic exteriors and fighter-pilot inspired cockpits, a common theme ran through these future designers' concepts — each vehicle reflected a relatively specific activity for which it was designed.

For example, a "2-passenger plus light, bulky load" vehicle, with its two passengers seated fore and aft along one side and a long trunk arranged parallel to them, appeared ideal for hauling sports gear such as golf clubs or skis.

Case in point No. 2: global competition. The accelerating globalization of the auto industry will end in a worldwide Big 3 automakers, and they certainly will not be General Motors, Ford Motor Co. and Chrysler Corp. (although one of these may be among the new Big 3).

Those who doubt that a new, global version of the Big 3 automakers will emerge need only recall Michelin's recent acquisition of Uniroyal Goodrich, putting Michelin in the lead in the three-way race for global leadership in the tire industry.

Case in point No. 3: automotive retailing. In the United States and around the globe, the way motor vehicles are distributed, sold and serviced will also reflect this rapid pace of change.

J.D. Power and Associates, which has been tracking changes in the U.S. automotive retail system for more than 20 years, is predicting that during the next 20 years there will be a major consolidation in the number of retail sales outlets.

Also predicted is a similar reduction in the number of franchise owners and a proliferation of a new type of retail service outlet - the factory-authorized franchised service garage, handling both warranty and post-warranty work.

It is on the third arena of change that we want to focus here. We most recently took an in-depth look at these changes earlier this year in a publication titled *The Revolution in Automotive Retailing: A Special Report on Consumer-Driven Changes in the U.S. Dealer Franchise System.* In preparing this study, we recognized that the foundation for sweeping change in the franchise system has already been laid. A brief look at history illustrates this point.

Author David E. Whiteside is director of publications for J.D. Power and Associates.

Winning retailers will have the widest choice, best on-spot delivery capabilities and best price. AUTOMOTIVE NEWS/JOE WILSDENS

CONSOLIDATION OF U.S. AUTOMOBILE DEALERS

	1985	1990	2000
Dealer principals	17,660	16,000	8,000
Retail sales points	24,700	25,000	18,000
Factory-authorized service outlets	—	—	5,000

SOURCE: Revolution in Automotive Retailing ©1989 J.D. Power and Associates

In 1950, there were 47,500 new-car and -truck dealerships across the United States. Most of these sales outlets were owned by hometown entrepreneurs, and the overwhelming majority of them held one franchise to sell one brand of domestic car or truck. Only a handful of import franchises was available. Detroit ruled supreme in this one-man, one-franchise system.

Today, there are only 16,300 dealer principals operating 25,000 retail sales outlets. Two-thirds of these hold more than one franchise. Moreover, 30 percent of U.S. dealer principals hold at least one Asian franchise, and 20 percent hold at least one European franchise (total percentages do not equal 100 because of dual ownerships).

All that is a matter of record. We are predicting that the dramatic consolidation in the U.S. new-vehicle retail industry is far from over.

Indeed, the increasingly competitive market conditions that will continue to dominate the auto industry during the next decade or longer will drive a substantial number of these dealer principals out of the industry. By the year 2000, there will be only 8,000 dealer principals in the United States. They will operate a mere 18,000 retail sales outlets.

Other changes we foresee in the franchise system include the following:

- To satisfy consumer demand for convenient, hassle-free shopping, light-duty motor vehicles increasingly will be sold in environments that will approximate those found today among mass merchandisers of consumer electronics and home appliances.
- As consumers travel farther from home to purchase their cars and light trucks in these centralized locations, brands will be forced to share — and compete for — the automotive equivalent of shelf space. The name of the retailer will come to have equal or greater meaning than the manufacturer's brand, just as it does today in television sales, for example.
- A corollary of this development, however, will be a need for a new type of service facility that can offer warranty service as well as post-warranty service.

Already there are signs that the manufacturers are becoming willing to create a new type of factory franchise: the factory-authorized service franchise. Witness, for example, Saturn Corp.'s decision to permit separate sales facilities and GM's plan to certify 2,000 independent service shops as Delco-Tech Service Centers, both of which are but early signs of this shift.

- As the size of investment required to create the new type of automotive mass merchandising center grows, many traditional dealer principals will cease to be able to compete. New players such as financial institutions, public companies and other legal entities will emerge to share the field with those individuals who are able to survive under the new conditions.

Thus, not only have the domestic makes lost control of the U.S. new-vehicle market, but all manufacturers, who as a group were the natural industry leaders when production was king, have ceded control to the consumer.

This consumer-driven market is characterized by increasing choice and availability as new nameplates and models of both cars and light trucks continue to enter the U.S. market. Moreover, the opening of more transplant assembly operations coupled with the domestic industry's determination not to surrender more market share is producing an over-abundant supply of virtually all makes and most models.

The U.S. automakers' continued reliance on sales incentives and rebates plus many imports' decision to join the battle demonstrates vividly the impact of this shift to a buyer's market. As J.D. Power and Associates data reveals, the gap in perceived product quality continues to narrow.

The direct consequence is a market in which product differentiation is diminishing and the competitive edge increasingly will go to the retailer with the widest choice, best on-spot delivery capabilities and best price.

This is the formula of the mass merchandiser. The new-vehicle franchised dealer system as it is known today is laboring even as the pace of the race quickens.

SEE THE LISTING BELOW FOR LOCATIONS AND TELEPHONE NUMBERS OF OUR AUCTIONS.

Albuquerque Auto Auction Inc.
505/883-7772

Amarillo Auto Auction Inc.
806/358-3663

Aptco Auto Auction Inc. (Detroit)
313/285-7300

Arena Auto Auction Inc. (Chicago)
312/759-3800

Baltimore-Washington Auto Exchange Inc.
301/796-8899

Bayside Auto Auction of Tampa Inc.
813/620-3600

Capital Auto Auction Inc. (Columbia, SC)
803/794-9051

Colorado Springs Auto Auction Inc.
719/392-3406

Dallas Auto Auction Inc.
214/264-2344

Dealers Auto Exchange of Tucson Inc.
602/574-2222

Fort Wayne Vehicle Auction Inc. (Indiana)
800/999-2150
219/422-9577

Golden Gate Auto Auction Inc. (San Francisco)
415/637-5660

Lauderdale—Miami Auto Auction Inc.
305/791-3520

Metro Auto Auction of Kansas City, Inc. (Missouri)
816/525-1100

Minneapolis Northstar Auto Auction Inc.
612/445-5544

Mississippi Auto Auction Inc. (Hattiesburg)
601/268-7350

Nashville Auto Auction, Inc.
615/244-2140

Omaha Auto Auction Inc.
402/896-8000

Puget Sound Auto Auction, Inc. (Seattle, WA)
206/735-1600

Southern States Vehicle Auction of Atlanta Inc.
800/223-2150
404/939-1618

Tri-City Auto Auction, Inc. (Pasco, WA)
509/547-1701

West Palm Beach Auto Auction, Inc.
407/790-1200

Auction Transport Inc.
800/233-1301

Anglo American Auto Auctions Inc.
435 Metroplex Drive
Nashville, Tennessee 37211
615/333-1400

Service needs keep slipping

Better product quality means greater durability, reliability

What service in the 1990s will be like has a lot to do with what vehicles of the 1990s will be like.

Manufacturers acknowledge that product quality and the quality of service will be the major discriminators between the winners and the losers in sales.

Better product quality means greater durability and reliability. Simply stated, things will last longer and not break as often. The need for repair service has been declining and will continue to do so.

Years ago engine valve jobs and piston ring replacements used to be common. Not anymore, and that trend is going to continue. Exhaust systems are now made of stainless steel. What used to last two or three years in the Rust Belt now lasts five or six years. Outside the Rust Belt the stainless steel exhaust system is virtually a lifetime system.

For many, visits to the repair shop for costly repairs are going to cease.

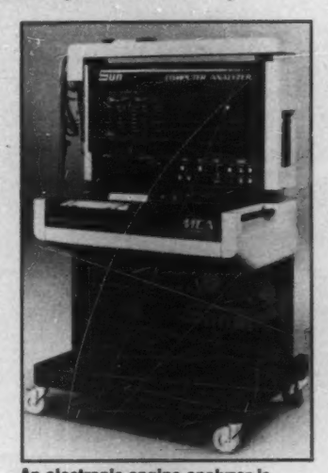
Where vehicles go for service won't change much from today. If something major breaks when the vehicle is under warranty it will go back to the dealer. Vehicles that need repair after the warranty will go to dealers, gas stations, specialists and independent repair shops. With the decline in repair work due to higher product durability and reliability, the service business will become very competitive on price and customer convenience.

The use of electronically controlled systems on new vehicles has been exploding over the past five years. This is sure to continue into the mid-1990s. But then the pace of new electronic systems will slow; by then every major vehicle system will be electronic.

In spite of the reputation that "black boxes" have earned in the past, they do bring some great service benefits.

First, as the pace of new electronic controls slows, the service industry will become very competent at making diagnoses and repairs.

Second, the diagnostics for these electronic systems will be standardized and on the vehicle, making it easier to obtain competent repair service.



An electronic engine analyzer is used for diagnoses and repair.

Finally, electronics will make it possible to place a vehicle maintenance reminder system on the vehicle that determines the maintenance needs of the vehicle based on its use. Every owner will have a customized maintenance schedule to follow that will insure even greater durability for the vehicle.

Regular preventive maintenance will become the key service item.

Things like oil changes, filter changes, spark plug replacement, lubrication, wiper blade replacement and periodic inspections of wear items like belts, hoses and brake pads will continue to be necessary. The intervals for oil changes will probably not be extended any further than the current 7,500-mile recommendation. But spark plugs that needed to be changed twice a year 10 years ago now only need to be changed three or four times in a vehicle's lifetime. Brake pads that used to need to be replaced every 24,000 miles now easily go 50,000 to 60,000 miles.

What is the future of the do-it-yourselfer? He will still be around. There just won't be as many things that will need repair or attention.

A person works on his own vehicle because of economics and self satisfaction. These reasons have nothing to do with the vehicles.

Regular preventive maintenance will still be necessary. Alternators, starters, batteries, shock absorbers, struts, spark plug wires, distributor caps, belts, hoses and brake pads will still be on vehicles and will still need to be repaired or replaced. These things will not fail as often or need to be serviced as often. The do-it-yourselfer will still work on his vehicle, he just won't need to do it as often.

Hazardous waste disposal is going to be a rising issue throughout the 1990s. Freon, anti-freeze, waste oil and batteries will require special disposal methods to minimize any negative impact on the environment. The cost to manage these volumes of hazardous waste will mean some increased costs to the providers of service and some new restrictions that the do-it-yourselfer will have to deal with. But these problems will be overcome with time.

The need for service in the 1990s is going to decline. To the vehicle owner that means less expense in vehicle maintenance. It also means a lot of the service providers are going to try and attract business by pricing their service at attractive levels and offering their service at the convenience of the customer. The 1990s will also see the tidal wave of black boxes slow down so everyone in the service industry can catch up with the technology. ■

Author Robert Johannes is chairman of the Car Care Council.

The chemical aftermarket

Overall, modest growth is predicted for the next decade

A variety of influences will have a profound effect on various segments of the consumer automotive chemical aftermarket.

Environmental restrictions, extended auto manufacturer warranties and technological developments that reduce the need for maintenance will slow some segments of the market. On the other hand, changes in new market opportunities, industry restructuring, pricing and increased consumer diligence/awareness will allow some manufacturers to enjoy healthy market growth rates during the same period.

The overall market is projected to grow 4.4 percent during the next decade, reaching $7.7 billion by year 2000.

In 1988, wholesale shipments of automotive chemicals to consumer aftermarkets (retailers and professional services) represented 59 percent or $4.6 billion of the total market. The original equipment manufacturers segment of the automotive chemical market will increase its market share only marginally during the next decade — from 41 percent to 42 percent of the total.

Ethylene shortages and subsequent huge price increases dramatically impacted the antifreeze and coolant segment of the consumer aftermarket. As raw material supplies increase with new ethylene capacity coming on-stream, the 13.7 percent annual growth enjoyed between 1982-1988 for these products will drop to 1.9 percent through 2000.

The autobody products segment of the consumer automotive chemical industry will also experience a decline as manufacturers increasingly provide rustproofing as original equipment, and superior coatings and paints come into use.

Leading Edge Reports, a Cleveland-based market research firm, provided this article.

WHOLESALE MARKETS FOR AUTOMOTIVE CHEMICAL PRODUCTS

(millions of dollars)

	1977	1982	1988	1995	2000
Wholesale shipments	2,704	3,506	5,542	7,090	9,135
Professional service	917	1,111	2,084	2,700	3,500
Retail outlets	1,787	2,395	3,458	4,390	5,635
% of professional service	33.9	31.7	37.6	38.1	38.3

SOURCE: Leading Edge Reports

Improvements in original equipment manufacturer coatings and structural materials, changes in paint formulas and application technology, and various environmental regulations will slow the annual growth of this market segment from a healthy 10.4 percent during 1977-1988 to 5.3 percent during the next decade.

On the positive side, consumption of consumer maintenance products (a loosely defined catch-all segment of the industry) will experience the highest growth rate during the next 10 years.

This segment, which includes carburetor cleaners, degreasers, solvents, de-icers, penetrants, air-conditioning refrigerants, tire patch-and-fill materials and many other products sold in both bulk and aerosol form, will grow 8 percent annually from $295 million in 1988 to $735 million by 2000. A constant flow of new products will help keep this a dynamic market.

The consumer automotive chemical industry is divided between retail sales to do-it-yourselfers and the professional service industry. The do-it-yourselfers will retain the largest share of the market for auto-chemical products through 2000. In 1988, wholesale shipments to retail outlets amounted to more than 62 percent of the total market. Due in part to increased consumer diligence/awareness toward maintaining their expensive automobile investments, this level will be maintained throughout the coming decade and reach more than $5.6 billion by 2000.

The professional service industry makes up the remaining share of the wholesale market. Automotive repair shops, tune-up facilities, service stations, quick lubes, car dealerships, etc., had sales of more than $2 billion in 1988.

The fastest growing segment of the market, quick lubes, will enjoy growth rates as high as 15 percent annually during the next decade. There could be some risk, however, to the small entrepreneur who ventures into this market, since oil company-owned chains could enact price-cutting strategies to drive out the small operators.

Only half of the service stations in operation in 1972 survived into 1988, and the number is expected to continue to shrink through 2000. On the other hand, sales volume per station will increase as more automotive and non-automotive services are expanded, (e.g. video sales, car washes, full-maintenance services, convenience stores, fast food, etc.).

The surviving stations, however, are expected to become tightly controlled by the major oil companies.

A major concern throughout the automotive chemical industry will continue to be clean-air regulations, which are expected to have a major influence on chemical use and disposal through 2000. Paint shops, already suffering reduced profits as a result of restrictions on emissions, will see keener competition as the chains increase their domination over this market.

CONSUMER AFTERMARKET FOR AUTOMOTIVE CHEMICALS

(millions of dollars)

	1977	1988	2000	Percent annual growth 1977-1988	Percent annual growth 1988-2000
Oils, greases and fluids	**924**	**1,257**	**2,010**	**2.8**	**4.0**
Motor oils	704	929	1,425	2.6	3.6
Greases	71	110	180	4.1	4.2
Fluids	149	218	405	3.5	5.3
Additives	**123**	**245**	**458**	**6.5**	**5.4**
Oil additives	77	153	280	6.4	5.2
Fuel additives	36	76	150	7.0	5.8
Transmission additives	10	16	28	4.4	4.8
Cooling system products	**455**	**1,218**	**1,530**	**9.2**	**1.9**
Antifreeze	419	1,146	1,415	9.6	1.8
Antifreeze/radiator additives	36	72	115	4.1	4.0
Other maintenance	**110**	**295**	**735**	**9.4**	**7.9**
Auto body products	**372**	**1,101**	**2,050**	**10.4**	**5.3**
Paints	240	767	1,515	11.1	5.8
Rustproofing	43	179	250	13.8	2.8
Body fillers	25	43	95	5.1	5.8
Adhesives and sealants	64	112	190	5.2	4.5
Appearance products	**238**	**510**	**946**	**7.2**	**5.3**
Wax, polish, protectants	196	417	785	7.1	5.4
Car wash products	28	66	120	8.1	5.1
Windshield washer fluids	14	27	41	6.2	3.5
Total consumer aftermarket	**2,224**	**4,626**	**7,729**	**6.9**	**4.4**
Dollars spent per auto	19.56	32.65	43.17	4.7	2.0

SOURCE: Leading Edge Reports

The automotive chemical aftermarket consists of two main segments, the commercial aftermarket and the consumer aftermarket. Commercial applications of automotive chemicals involve some 40 million trucks and other motor vehicles used to transport goods or people for commercial purposes. The consumer aftermarket consists of more than 140 million motor vehicles used to transport people, typically for private, non-commercial purposes.

Shipments to the consumer segment accounted for nearly 60 percent of the total $7.8 billion automotive chemical market in 1988. Average annual growth of the consumer aftermarket was nearly 7 percent as shipments rose from $2.2 billion in 1977 to $4.6 billion in 1988. Demand is expected to exceed $7.7 billion by 2000.

Various factors contribute to consumer aftermarket demand. Some of the most important are the size and age of the automobile population, automobile prices, fuel prices, automotive technology, disposable consumer income and development of new automotive chemical products. Effective marketing, promotion and distribution are essential in this market, and distribution systems are complex.

Of the $4.6 billion worth of automotive chemical product shipments to the consumer aftermarket in 1988, more than 27 percent were lubricants. This $1.2 billion product group included motor oil, greases and related fluids. The lubricants segment was characterized by only modest price growth during the 1980s. ▶

3 groups to watch in '90s market

Baby boomers, women and seniors will play dominant roles

In hindsight, many remarkable marketing success stories seem to be almost sure things — the premises were obvious, the strategy was clear.

A product is brought to market at just the right moment, or a growing need and ideal solution converge in the marketplace, and everything is roses from there on.

And yet, an equal or greater number of opportunities, prospects and niches are not seized or exploited even as they lie, just as apparently, right before us.

The most obvious explanation, of course, is that while hindsight is 20/20, foresight is not.

Nevertheless, as we prepare for the marketing challenges of the next decade, the more attention we can give to the social and economic trends that will define the automotive market and the more we can anticipate the customer needs and concerns growing out of those trends, the more likely we are to be the architects of our own success. While the future cannot be foreseen, we invent it every day.

Of the possible social and economic trends that might be identified, demographic trends are among the more important. Their usefulness lies in establishing a key definitional component of the market, namely, the basic, identifying characteristics of the people that will comprise it.

In that regard, we have identified three groups that will be particularly significant in the automotive marketplace. They are the ubiquitous baby boomers, women and senior citizens.

The boomers

By now, we are all thoroughly familiar with this 2,000-pound gorilla of the marketplace. The music we hear, the television we watch and the products we buy are all influenced, if not determined, by this concentration in the population.

But if you think it's bad now, just wait until the 1990s. The 1990s will differ from all previous decades in that the baby boomers will maximize their incomes.

What does that mean for the auto industry? First of all, it means that the industry must determine who these people are, or more precisely, what the boomer submarkets look like.

Although the model boomer of the 1990s may look like a character from *fortysomething*, not all boomers are alike. The increasing age, income and fertility of a large number of the boomers are probably the most significant elements to be considered.

But that does not mean that the stereotypical childless, two-wage-earner yuppie couple of the 1980s will disappear. They will still exist, but as a smaller segment of the overall marketplace. Their importance to a marketing strategy will depend in part upon the particular product mix being marketed to them.

In broad strokes, though, the maturing of the boomers means that there will be far more disposable income available for automobile purchases.

That fact, coupled with the projection that sizable numbers within the group will be experiencing mid-life crises, suggests that some fairly upscale manufacturers (Porsche specifically comes to mind) may see a significant increase in the demand for their products.

That will be true so long as they can resist or reverse the image dilution that has consistently accompanied the downsizing and cheapening of some of the luxury vehicle lines.

Certainly, the mid-life-crisis phenomenon will not be the only demographic surge arising from the boomers. The current trend among the boomers to save more of their incomes, be more concerned with the quality of life and concentrate on providing for their children's future will also have an impact.

In that regard, another prediction can safely be made. Many of the children of the baby boomers — members of the baby boom echo — will reach driving age. Unfortunately, in the transportation area, they are more likely to be the victims, rather than the beneficiaries, of their parents' wealth accumulation.

While the boomers themselves may be in the market for some fairly upscale vehicles, they will be in no mood to extend the same courtesy to their children after all those years of saving and sacrifice. Instead, just as was true for their parents, the children of the boomers will create a sizable market for sturdy and safe, but necessarily low-priced, automobiles.

Another likely outlet for the boomers' excess wealth, and one related to the quality-of-life concern, will be recreational properties. And along with the demand for recreational properties, there will be a parallel demand for recreational vehicles. Thus, the market for four-wheel-drive cars, trucks, Jeeps and related vehicles will increase during the 1990s.

But the demand for RVs will most likely have an additional impact: a reduction in demand for minivans and station wagons. As their children mature, the boomers' need for such vehicles will decline. That will happen at the same time that their interest in RVs will be driven upward by their life circumstance.

While those dual trends do not imply that there will be no substantial demand for the now popular minivans, it does suggest that the demand will level off or even decrease as the decade progresses.

Finally, the dominant trend for wealth accumulation within the baby boom generation also has a negative counterpart. The already significant economic underclass will continue to expand during the 1990s.

As the wealth distribution follows today's trend toward bipolarity, a substantial portion of the population will be excluded from the new-car market because of its economic status. Some solace will be provided to the dealers (though not the manufacturers) by a flourishing used-car market that will maintain its strength as we proceed into the next decade.

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GENERAL INFLUENCES ON AUTOMOTIVE SALES

	1977	1982	1988	1995	2000
Resident population (millions)	220	232	246	260	268
Adult resident population (millions)	154	169	183	194	202
Registered automobiles (millions)	114	125	142	162	179
GNP ($billions)	1,918	3,073	4,864	7,590	10,550
Consumer expenditures ($billions)	1,204	1,992	3,228	5,080	7,070

SOURCE: Leading Edge Reports

Porsche 928 automatic could attract more buyers in the 1990s as the Baby Boom generation maximizes its income.

Women

The economic power of the baby boom generation is not the only trend that will define the market of the 1990s.

The increasing social integration and market power of American women will be felt even more in the next decade. Industry statistics show that women now represent 45 percent of new-car purchasers and are involved to some extent in 80 percent of all new-car purchases.

Indications are that those figures will increase to the point where women exercise at least as much power in the automotive marketplace as men.

A successful response to that new market reality must go beyond designing advertisements that say, "We like women customers." A heightened sensitivity to the desires and *sensibilities* of women customers is the necessary next step. In that regard, the auto industry might heed developments in the television industry, which is continually responsive to mass consumer tastes.

Recent programs that have been most successful, both critically and, more significantly, commercially (e.g., *Murphy Brown* or *Roseanne*) are shows that feature women in prominent decision-making roles.

To the extent that women represent a distinct market segment, the breakaway automotive marketing successes of the 1990s will be generated by production and marketing concepts that feature women in decision-making roles.

Most likely, the creation of campaigns and media responsive to those audiences will require the active involvement of key female participants, such as Laurel Cutler, vice president of Consumer Affairs at Chrysler.

But working toward the functional empowerment of women in the traditionally male-dominated automobile industry will be no small task. Especially since such changes must occur at both the manufacturer and dealer levels.

But it is anticipated that two benefits will accrue from those changes. First, the product mix offered by manufacturers will more likely address the needs of women in the marketplace. Second, the approach to service within dealerships (and supported by manufacturers) will be more sensitive to the expectations of women customers.

Both of those benefits are necessary to build a strong and loyal customer base among women. That base will be critical to the success of dealerships in the 1990s.

Seniors

The final dominant demographic trend may have more implications for the transportation industry than the auto industry in particular. That trend has been generally referred to as the "graying" of America: the increased number of senior citizens in the population.

Since the large senior population will expand greatly as some baby boomers approach retirement age, improvements in housing, health care and transportation will occur.

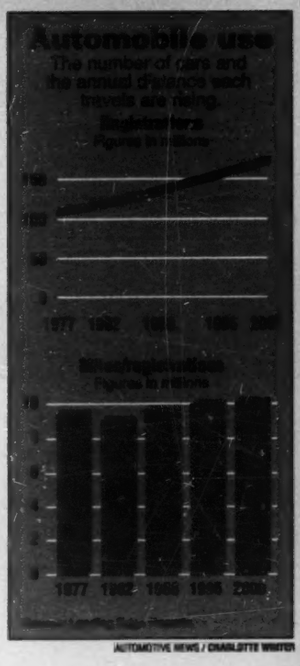
It is difficult to predict exact events and their impact on the automobile industry, but one assumption is safe: There should be an increased need for maxivans — van-type vehicles that are somewhat larger than traditional vans.

Some of those vehicles are already on the market, but the demand will increase as society begins to deal with the growing needs of an expanding elderly population.

Conclusion

We have approached the topic of demographic influences on the 1990s automotive market with the assumption that the auto industry will monitor the changing demands of the marketplace and respond to them. Such monitoring should, at the very least, involve three dominant groups — baby boomers, women and the elderly.

Admittedly, the broad industry implications described for each of the groups are only the most general guidelines. We cannot at this point predict sudden shifts in the preferences of group members, only that those groups will have a dominant influence on the marketplace.



AUTOMOTIVE NEWS / CHARLOTTE WHITE

Clearly, there is a critical role for market research to provide accurate information on consumer preferences and expectations as the new decade approaches.

Finally, and most important, we should emphasize that the product and process discussions for the three demographic groups have had one underlying and dominant theme:

All three groups are distinguished by a concern for value in their purchases. Thus, the concern for monitoring and improving customer satisfaction that has become the watchword in the late 1980s will be even more important in the next decade. Demographic trends are simply too strong to ignore that point.

The 1990s will be the decade in which tracking and responding to customers' expectations will be honed to a fine art. Those who are not preparing to do that will find their business success placed upon a precipice, ready to fall with the dawning of the new decade. ■

Star-gazing with the analysts

They see slow start for '90s, then upturn; gains for transplants

Analysts and auto industry experts expect a level car market with slim annual growth rates of 1 to 1.5 percent in the early 1990s.

The rosy 10 percent increases of the mid-1980s aren't in the cards, although analysts expect some improvement in the mid-1990s.

Competition will be fierce. Manufacturers will look upon this decade as the "easy '80s," and they will view the next 10 years as the "competitive '90s," said analyst, Chris Cedergren of J.D. Power and Associates in Agoura Hills, Calif.

Some kind of slowdown is inevitable, analysts say, but it will be followed by a creeping recovery. "A lengthy shallow downturn is more likely than a sharp deep recession for the 1990s," according to the recent University of Michigan Delphi V study of auto industry executives and managers.

In the short-term, Ted Sullivan of the WEFA Group in Bala Cynwyd, Pa., said, "We're not expecting a lot of improvement. Affordability conditions remain weak. High interest rates are affecting car loan payments." WEFA looks for sustained growth through 1992, depending on the rate of inflation.

Analyst David Healy of Drexel Burnham Lambert in New York, agreed that there will be some kind of downturn in car sales, most probably in 1990. Scott Merlis, an analyst with Morgan Stanley in New York, said he doesn't forecast recovery until 1991.

Bernard Campbell, Data Resources/McGraw-Hill director of transportation and automotive services, said, "Right now, we have as many cars as we need on the road. We have a stock of about 170 million vehicles and there about 190 million people of driving age. That's very close to a 1-to-1 ratio. It's very difficult to get much beyond that.

Campbell said that "the long-term outlook for the car market is very slow growth."

"I don't think any of the car companies are going to have much fun in the next few years," observed Ann Knight, analyst and vice president of Paine Webber in New York. "And that's surprising news because Data Resources and our firm have forecast a pretty good economic climate."

Vehicle sales will be sluggish in the next few years because of slower economic growth, price increases on new vehicles, a bulging supply of late-model vehicles on the road and a softening of vehicle resale values, according to Michael Luckey of Michael Luckey Consulting Group in Cresskill, N.J.

Sales will rebound and move upward by 1992, Luckey and others believe. Peak years for the auto industry are projected in 1992 and 1993.

For 1992, Knight projects a 16.2 million light-vehicle market, and Merlis said he sees a market of nearly 17 million vehicles in the United States.

If the dollar stays where it is, the Big 3 can be written off, said Ronald Glantz of Montgomery Securities in San Francisco.

"Presently, the Japanese can deliver a car for $300 less than we can build one, and transplants can build one for $650 less than Detroit," he said. In the future, Japanese and Korean unit labor costs will go up less than those in the United States; their advantage increases, he said.

About 20 percent of Big 3 sales could be cars made in partnerships, such as Ford selling Mazda-made cars.

AUTOMOTIVE NEWS/JOE WILSON

A rosier long-term outlook is projected by auto industry experts polled in the Delphi V survey by the University of Michigan's Transportation Research Institute.

A healthy consolidation period for a decade of strong worldwide economic expansion beyond 2000 is expected, according to Delphi respondents.

Still, inflation is running at its fastest clip since 1982, said Data Resources economists and Lester Thurow, dean of the Sloan School of Management at the Massachusetts Institute of Technology. Thurow said that since 1982, Americans have consumed $800 billion in imported products that aren't even paid for.

DRI and Thurow said that business is obsessed with short-term profits. Mergers and acquisitions have created more debt than most firms can handle. It may also create a bigger debt in the next year and a half and hence a tougher market for consumers.

Production outlook

Vehicle production forecasts will have to be more realistic because of increased competition and the growth of transplants' manufacturing capacity.

A study by Autofacts Inc. of Philadelphia said that seven assembly plants will open and three will shut down in the next five years. Capacity is expected to climb 14 percent to reach 16.3 million units by 1994.

Current utilized capacity for all 82 automotive plants producing cars and light trucks in North America is about 87 percent, according to the study. In 1989, utilized capacity is expected to drop 3 points from last year, and in 1990 Autofacts sees it declining another 5 points. But during the 1991-94 period, Autofacts expects capacity utilization to average 84 percent with transplant competitors.

But there will be a production shortfall of U.S.-built light trucks in the early 1990s, according to William R. Pochiluk, president of Autofacts. "The capacity problem is mostly a car problem. In fact a shortage of domestic light-truck capacity is expected by the early 1990s," he said.

Cedergren agrees that by the mid-1990s, most production capacity will be "rectified." He said General Motors is expected to close four plants while Ford and Chrysler should each close one.

The big story will continue to be the transplants' increasing share of car and light-truck production. It will rise to at least 15 percent in the next decade, many analysts say.

Transplant production will increase from 900,000 in 1988 to 1.9 million in 1992, according to Campbell, "For every three transplants sold, two domestics will be displaced — and one import," he said.

Transplant production will be running at a healthy 75 to 80 percent of capacity by 1992, although it will not be pushing all out, according to Healy. In 1988, transplants earned an 88 percent capacity rate overall, well above average performance for cars, the Autofacts study reported.

Sales outlook

All the growth in the light-vehicle market will be in light trucks, analysts say. Cars will be flat.

The passenger-car market will continue to be a battleground between domestic and import makes, according to the University of Michigan Delphi V study. Sales will rise about 1 percent per year, but certain segments will decline, the respondents suggested.

The U.S. marketplace is already international, according to analyst Maryann Keller of Furman Selz Mager Dietz & Birney in New York. By 1997, she predicts, even if foreign-based firms fail to meet their sales targets, "non-U.S." brands will account for 45 percent of the cars and 23 percent of the trucks sold."

The most exciting demographic variable in the 1990s will be: What will the maturing baby boomer buy? By 2000, more than half the population will fall into the generation born from about 1945 to 1960.

In the past, older drivers have preferred domestic makes, according to market research from Newsweek, Advertising Age and some of the car companies. That may change with the baby boom generation. They may choose upscale versions of import makes that they now drive, many analysts believe.

Light-truck and van makers will do what the Japanese have done. They will evolve their truck products into more luxurious vehicles. Manufacturers selling both cars and trucks/vans in the 1980s include Chevrolet, Ford, Dodge, Plymouth, Toyota, Nissan, Mazda, Mitsubishi, Isuzu and Volkswagen.

Oldsmobile and Pontiac have introduced vans, and Mercury will be selling both cars and trucks. Transplant Honda is expected to become a U.S. van manufacturer, too. U.S. truck sales already account for more than one-third of the new-vehicle market. Research by GM shows that 40 percent of U.S. households own at least one truck. A decade ago, the figure was 25 percent.

It's been estimated that nearly a million car buyers have crossed over to buy sport-utilities, pickup trucks or vans. The real growth is expected in compact pickups, vans and sport-utilities.

A time for transplants

Transplants will continue to take an increasing share of production and sales in the United States, according to analysts.

Overcapacity has already begun to surface and will still be around for another 10 years, according to Keller and other consultants who believe transplants will be underbuilding by 1992. Although able to produce two million vehicles, plants will run at 75 to 80 percent capacity to make about 1.5 to 1.6 million vehicles, they say.

The greatest risks are to the Big 3, analysts concur.

Imports from Japan will trend downward, and transplant production will grow from about 10 percent to 15 percent in the next 10 years, Luckey bets.

In the next decade, the Koreans — most probably Hyundai — will be building in the United States. The transplant light-truck area is starting to blossom. Unless there is any sign of the 25 percent tariff disappearing, it makes sense to produce trucks here, Luckey said.

▶

SHARE FORECASTS FOR U.S. CAR MARKET

	Manufacturers forecast			Suppliers forecast		
	1990	1995	2000	1990	1995	2000
Big 3 production in N. America	61%	60%	60%	61%	60%	58%
Japanese imports	18	16	15	18	16	15
European imports	6	6	5	6	6	5
Japanese assembled in N. America	5	7	8	6	8	10
U.S. manufacturers' imports	3	3	3	3	3	3
Korean imports	3	3	3	3	3	4
Joint venture production in N. America	2	3	3	2	3	3
Other assembled in N. America	1	1	1	1	1	1
Other imports	0	0	0	0	0	1

NOTE: Total may not add to 100% since some of the participant responses did not add to 100%.
SOURCE: Arthur Andersen & Co.

Author Philly Murtha is an Automotive News staff reporter.

Imports and exports

The import segment, particularly Japanese imports, will trend downward, analysts say. But they will still gain sales at the expense of the Big 3 automakers. According to the University of Michigan's Delphi V study, the largest Japanese companies will grow larger and the smaller sellers will hold their ground.

The import share will rise from 30 percent in 1988 to 35 percent in 1991, according to Campbell, who suggested that the Japanese growth will be in fleet sales and potential conquest sales in mid-America. He said the Big 3 have narrowed the quality gap, but there is still a lag in perception.

Small niches will have to be carved out by the overseas vehicle makers to preserve a place in the U.S. car and light-truck market. Winners will be companies that can excite buyers in the luxury class, too.

Luckey suggested that it will be an interesting opportunity to convince upscale buyers to purchase more trucks. "The Jeep Cherokee and the Range Rover, for example, could appeal to upscale baby boomers. Japanese makers may pursue this segment. An upscale minivan from Honda has been rumored for years," he said.

Import penetration has already peaked and will continue to move downward in the next decade, according to Glantz.

The willingness of various states to subsidize plants means the transplants' share will continue to rise, he said. That will take sales from the import market, too.

Effect on market shares

GM recently said that it intends to capture 37 percent of the U.S. car market in 1990. For the first nine months of 1989, GM held 35.41 percent. Ford Motor Co. was the only one of the Big 3 to gain in share of the car market. It held 22.34 percent in the first three quarters.

In a three- to five-year period, GM will be vulnerable, but its share will probably remain stable, Luckey said. Its share has already slipped several percentage points. Although Chrysler's car share fell to 10.32 percent in the first nine months of 1989, light-truck sales will help it hold its own, Luckey said. Ford will continue to do well because it has established a certain amount of loyalty, analysts said.

The big theme for the next decade will be that the Big 3 will do somewhat better with the truck side of the business. Of course, there will be price increases due to changes in regulations affecting vehicle safety requirements.

Some analysts believe that competition from the current players plus three or four additional competitors in the next decade will break down market shares even further.

Analysts suggest that the Big 3 will take 58 to 63 percent of the U.S. car market by the mid 1990s, compared with 68.07 percent in the first nine months of 1989. By the mid-1990s, Cedergren said, GM will probably hold onto 33.6 percent of the U.S. car market. Ford will keep 20.3 percent, and Chrysler's share will drop to 9.7 percent.

Including captives, their 1988 shares were: GM, 36.11 percent; Ford, 21.63 percent; and Chrysler, 11.25 percent.

Vying with GM for nearly a third of the car market will be all Asian makes. They claimed 25.59 percent of the U.S. market in 1988. The Europeans will remain stable and hold onto 5.0 to 5.5 percent, according to Cedergren.

Foreign nameplate sales, including imports and transplants, will scarf up about 36 percent of the car market in 1995, according to the University of Michigan's Delphi study.

But U.S. carmakers will pair up more with non-U.S. manufacturers in other countries to subcontract assembly and to develop and produce vehicles jointly, according to Keller.

On the other hand, Luckey figures that the German luxury car makers will lose share with the entry of Toyota's Lexus and Nissan's Infiniti. Lexus expects to sell 70,000 to 75,000 luxury cars next year; Infiniti's projections will be similar. That's a good chunk of business, he said.

Most of the analysts believe that those projections may be a little too bullish, considering the competitive nature of the market and the slowdown in the economy. ■

Automotive News World Outlook (Generated by Data Resources Inc.)

(In Hundreds of Thousands)

	1988	1989	1990	1991	1992	1993	1994	1995
New car registrations								
Total Western Europe*	12,905	12,911	12,590	12,831	13,036	13,213	13,405	13,730
Germany	2,808	2,751	2,757	2,823	2,752	2,711	2,765	2,842
France	2,217	2,272	2,138	2,238	2,323	2,327	2,361	2,434
United Kingdom	2,216	2,207	2,120	2,127	2,191	2,200	2,165	2,138
Italy	2,184	2,179	2,137	2,031	2,037	2,107	2,106	2,100
Total U.S.	10,591	9,908	9,765	10,052	10,385	10,394	10,444	10,606
Asia-Pacific**	1,506	1,793	1,851	1,932	1,960	2,042	2,126	2,200
Japan	3,717	3,908	3,764	3,856	3,770	3,901	4,009	4,089
Total Africa-Mid East	1,252	1,289	1,373	1,491	1,574	1,614	1,698	1,753
Total Latin America†	1,152	1,151	1,203	1,275	1,311	1,400	1,437	1,510
Total Eastern Bloc	2,249	2,274	2,329	2,407	2,484	2,541	2,612	2,649
Car production								
Total Western Europe*	13,032	13,070	12,813	13,071	13,299	13,563	13,727	14,067
Germany	4,346	4,388	4,285	4,408	4,476	4,467	4,511	4,618
France	3,224	3,245	3,130	3,229	3,337	3,352	3,427	3,557
United Kingdom	1,227	1,232	1,248	1,271	1,302	1,404	1,384	1,402
Italy	1,884	1,927	1,919	1,840	1,796	1,853	1,855	1,844
Total North American	8,145	8,603	8,822	8,675	8,867	9,130	9,577	9,635
Asia-Pacific**	1,258	1,593	1,812	2,014	2,114	2,270	2,344	2,418
Japan	8,198	7,943	7,644	7,841	7,750	7,747	7,861	7,977
Total Latin America†	1,278	1,293	1,383	1,435	1,479	1,570	1,612	1,686
Mexico	354	417	459	466	464	463	495	523
New truck registrations								
Western Europe***††	1,702	1,751	1,743	1,780	1,776	1,789	1,818	1,859
U.S.	4,800	4,600	4,600	4,900	4,700	5,000	5,100	5,400
Truck production								
Western Europe***	1,662	1,687	1,667	1,681	1,677	1,681	1,700	1,730
North America	4,600	4,900	4,800	5,100	5,000	5,200	5,300	5,600

*Includes Germany, France, United Kingdom, Italy, Netherlands, Belgium, Denmark, Ireland, Greece, Sweden, Norway, Finland, Switzerland, Austria, Spain and Portugal.
**Includes Taiwan, South Korea, Peninsular Malaysia and India but excludes Japan, which is listed separately.
***Includes Germany, France, United Kingdom, Italy, Spain, Sweden, Netherlands, Belgium, Denmark, Switzerland, Norway, Finland, Portugal and Austria.
†Latin America includes Mexico, Brazil and Argentina.
††Western Europe truck registrations and production numbers are for trucks over six tons; no vans.

May 1989

NORTH AMERICAN LIGHT- VEHICLE SALES

Year	18 million	16 million	14 million
1990	Good 7.8%	Medium 49.4%	Weak 42.8%
1992	Good 23.4	Medium 61.0	Weak 15.6
1994	Good 33.8	Medium 57.1	Weak 9.1
1996	Good 36.4	Medium 51.9	Weak 11.7
1998	Good 39.0	Medium 54.5	Weak 6.5
2000	Good 48.1	Medium 44.2	Weak 7.7

If a "good" sales year is defined as 18-million new cars and light trucks in the United States and Canada, 16-million is a medium year and 14-million a weak year, what are your expectations for years 1990, 1992, 1994, 1996, 1998 and 2000?

Responses to that question suggest a general leveling off of the overall market in the coming decade, rather than dramatic upward or downward swings. Also indicated is a rate of 1 to 1.5 percent sales growth a year.

Certain market segments are expected to show greater growth than others. Some segments might disappear. New ones may emerge.

As a result, manufacturers will have to target specific market segments, or niches, more accurately and swiftly than ever. They may need to increase marketing and related expenses — such as sales incentives, rebates and lower-cost financing — in order to bolster weak segments, especially during general economic downturns.

To implement aggressive market-share and price strategies while maintaining or improving profits, manufacturers will have to continually sharpen their internal cost structures, and concurrently increase prices based on improving value to customers and moving products upmarket.

AUTOMOTIVE NEWS/JOE WILSSENS

Foreign nameplate sales, including imports and transplants like Nissan, could have 36 percent of the market in 1995.

TOTAL U.S. PASSENGER CAR SALES

(Units in Millions)

	1990	1995	2000
Domestic	6.74	6.80	6.98
Import	3.41	3.78	3.93
Total	10.15	10.58	10.91

The passenger-car market will continue to be a battleground between domestic and import nameplates throughout the next decade.

Reason: The overall market for passenger cars in the United States is a very mature one, and sales are not anticipated to increase by more than 1 percent annually.

Although certain automobile market segments will grow faster, some segments will decline, resulting in weak overall growth.

In mature markets such as the United States, the only way to boost market share is to win customers from competitors.

Price, product differentiation, market responsiveness and merchandising will have to be integrated and executed strategically.

Foreign nameplate sales — including import and transplant — are forecast to increase their market share to 36 percent by 1995.

TOTAL U.S. LIGHT-TRUCK SALES

(Units in Millions)

	1990	1995	2000
Domestic	3.86	4.09	4.10
Import	0.90	0.96	0.94
Total	4.76	5.05	5.04

It is believed the U.S. light-truck market will grow slowly during the 1990s, although at a greater rate than passenger-car sales. This is consistent with maturing of the overall U.S. market, with specific pockets of growth.

Light trucks will continue to provide a flexible, functional alternative to passenger cars for primary transportation. Much of the growth will be within the gray area of vehicle classification between passenger cars and light trucks, such as multi-purpose passenger vans and sport-utility vehicles.

Imports are seen as being a competitive threat to the domestic Big 3, adding about 2 points of share from 1988 to 2000.

Charts and projections were provided by the University of Michigan Delphi V study.

TRADITIONAL DOMESTIC PASSENGER CAR SALES

(Units in Millions)

Production source	1990	1995	2000
General Motors	3.62	3.66	3.70
Domestic produced	3.30	3.30	3.30
Captive import	0.19	0.21	0.25
Transplant	0.13	0.15	0.15
Ford	2.11	2.12	2.28
Domestic produced	1.92	1.90	1.98
Captive import	0.09	0.12	0.15
Transplant	0.10	0.10	0.15
Chrysler	1.01	1.00	1.00
Domestic produced	0.81	0.80	0.80
Captive import	0.12	0.10	0.10
Transplant	0.08	0.10	0.10

A decline in passenger-car market penetration by at least two of the traditional U.S. Big Three auto companies may take place during the next decade.

General Motors' share of the new-car market in the United States may drop below 36 percent in 1995 and below 34 percent in 2000.

The Chrysler Motors Corp. share is seen falling one-half percentage point over the decade.

Ford Motor Co.'s new-car market share may stay about the same, or possibly rise a fraction of a percentage point.

A drop in sales share portends a corresponding drop in production by the traditional U.S. Big 3. Their slack would be taken up by increased output of transnational plants in the U.S., and increased outsourcing of small-vehicle production by the Big 3 domestics to overseas affiliates.

This would have a major impact on U.S.-based suppliers, since transplants and captive imports have significantly less domestic-supplier content than Big 3 brands.

IMPORT PASSENGER CAR SALES

(Units in Millions)

Production source	1990	1995	2000
Honda	0.80	0.93	1.00
Import	0.40	0.40	0.40
Transplant	0.40	0.53	0.60
Toyota	0.65	0.75	0.81
Import	0.50	0.50	0.50
Transplant	0.20	0.25	0.31
Nissan	0.52	0.56	0.55
Import	0.40	0.40	0.35
Transplant	0.12	0.16	0.20
Hyundai	0.26	0.31	0.33
Import	0.26	0.25	0.25
Transplant	0.00	0.06	0.08
Mazda	0.24	0.26	0.25
Import	0.15	0.16	0.15
Transplant	0.09	0.10	0.10
Subaru	0.16	0.15	0.14
Import	0.15	0.14	0.14
Transplant	0.01	0.01	0.00
VW	0.15	0.15	0.15
Import	0.15	0.15	0.15
Transplant	0.00	0.00	0.00
Volvo	0.10	0.10	0.10
Import	0.10	0.10	0.10
Transplant	0.00	0.00	0.00
Mercedes	0.09	0.10	0.10
Import	0.09	0.10	0.10
Transplant	0.00	0.00	0.00
BMW	0.09	0.09	0.10
Import	0.09	0.09	0.10
Transplant	0.00	0.00	0.00
Mitsubishi	0.09	0.09	0.10
Import	0.06	0.05	0.05
Transplant	0.03	0.04	0.05
Saab	0.05	0.05	0.05
Import	0.05	0.05	0.05
Transplant	0.00	0.00	0.00
Other	0.21	0.24	0.25
Import	0.21	0.24	0.25
Transplant	0.00	0.00	0.00

Big-volume importers are expected to become bigger, small-volume importers will hold their ground or climb slightly, and medium-size importers will maintain present sales levels or decline.

Also expected are increases in North American vehicle sourcing by the largest companies selling foreign makes here.

TRADITIONAL DOMESTIC LIGHT-TRUCK SALES

(Units in Millions)

Production source	1990	1995	2000
General Motors	1.50	1.60	1.60
Domestic produced	1.50	1.60	1.60
Captive import	0.00	0.00	0.00
Transplant	0.00	0.00	0.00
Ford	1.45	1.50	1.50
Domestic produced	1.45	1.50	1.50
Captive import	0.00	0.00	0.00
Transplant	0.00	0.00	0.00
Chrysler	0.91	0.99	1.00
Domestic produced	0.82	0.90	0.90
Captive import	0.09	0.09	0.10
Transplant	0.00	0.00	0.00

The light-truck market will be a hard-fought battleground into the year 2000.

Market growth during the 1980s has attracted a flock of new corporate entries and individual nameplates.

Sales battles will be waged within individual light-truck segments, with the likelihood that the passenger-car marketing and incentive wars of the 1980s will be emulated in the light-truck market of the 1990s.

From a market share perspective, the traditional U.S. Big 3 should remain competitive against imports and foreign transplants.

Popular opinion is that Chrysler will make the biggest share gains in the next decade. Its acquisition of Jeep vehicle operations is seen as a competitive plus. Chrysler's annual light-truck sales are forecast to grow to 1 million units by 2000.

General Motors is expected to maintain its share of the domestic market into year 2000. GM annual sales are forecast at 1.6 million units by 2000.

Ford's annual sales are expected to reach 1.5 million units by 2000.

IMPORT LIGHT-TRUCK SALES

(Units in Millions)

Production source	1990	1995	2700
Toyota	0.32	0.35	0.35
Import	0.32	0.33	0.30
Transplant	0.00	0.02	0.05
Nissan	0.20	0.24	0.23
Import	0.10	0.13	0.12
Transplant	0.10	0.11	0.11
Mazda	0.12	0.12	0.12
Import	0.12	0.12	0.12
Transplant	0.00	0.00	0.00
Isuzu	0.10	0.11	0.09
Import	0.08	0.09	0.06
Transplant	0.02	0.02	0.03
Suzuki	0.07	0.06	0.07
Import	0.07	0.06	0.07
Transplant	0.00	0.00	0.00
Mitsubishi	0.06	0.06	0.06
Import	0.06	0.06	0.06
Transplant	0.00	0.00	0.00
VW	0.01	0.01	0.01
Import	0.01	0.01	0.01
Transplant	0.00	0.00	0.00
Subaru	0.01	0.01	0.01
Import	0.01	0.01	0.01
Transplant	0.00	0.00	0.00
Other	0.00	0.00	0.00
Import	0.00	0.00	0.00
Transplant	0.00	0.00	0.00

Competitive pressures on foreign nameplates in the light-truck market are likely to remain strong in the 1990s.

It is suggested that the light-truck import market will follow a pattern similar to imported passenger cars: Large importers will become larger, while medium and small companies will struggle to maintain market share.

As with passenger cars, the Japanese are seen as putting their product-development-time advantage to use to seek out market niches and introduce products into emerging light-truck segments. Companies will expand their light-truck offerings into new segments or enter the light-truck market for the first time.

PERCENT OF TOTAL MARKET

Body type	1995	2000
4-door sedan	54%	54%
4-door hatchback	6	6
4-door station wagon	6	6
Subtotal	66%	66%
2-door sedan	21	21
2-door hatchback	12	12
Convertible	1	1
Subtotal	34%	34%

The mix of U.S. passenger-car body types will remain very much the same in the 1990s, as forecasters see it.

Four-door sedans will continue to be the most favored design, followed by two-door sedans, two-door hatchbacks, four-door hatchbacks/four-door station wagons (tie) and convertibles.

While body-style preferences remain stable, there will be changes in powertrain offerings as a result of shifts in consumer demographics and tastes. High-performance powertrains, once the domain of sleek two-door models, are finding their way into four-door sedans and station wagons.

NORTH AMERICAN PASSENGER CAR PRODUCTION CAPACITY

(Units in Millions)

Facilities	Current Estimate	1995	2000
Traditional domestic	9.3	8.6	8.5
Foreign-owned	1.2	2.1	2.5

Forecasts of passenger-car production capacity in the United States will continue to be a subject of speculation and debate in the 1990s.

Predictions as the decade gets under way are that the coming five to 10 years will see important shifts in North American car-production capacity, in terms of both industry and individual company volumes.

According to forecasters, the share of capacity by traditional U.S. Big 3 automakers will narrow from 89 percent in 1988 to 80 percent in 1995 and 77 percent in year 2000.

This trend suggests that the impact of transplant manufacturing and assembly operations in the United States will continue to be an issue in the years ahead, not only among Big 3 automakers, but also their supplier bases, labor unions, governments at all levels and other interested parties.

The increase in transplant share of production capacity is also an indication of greater participation of manufacturing in the United States by foreign supplier companies, not only with transplant customers, but with traditional Big 3 automakers as well.

It appears that the Big 3 will downscale their passenger-car production capacity over the next 10 years by approximately 10 percent, while foreign companies increase theirs collectively by more than 100 percent.

As a result, the grand total of North American capacity is expected to increase about 5 percent during the 1990s.

Given an estimated total North American market growth rate of 1.5 percent a year in the 1990s, the overall passenger-car market should expand by approximately 20 percent during the years 1989-2000, using a compounded rate over that time span.

U.S. PASSENGER CAR MARKET SEGMENTATION

(Units in Thousands)

Year/Segment	Domestic	Import
1990		
Subcompact, regular	977	1,329
Subcompact, specialty	78	86
Compact, regular	914	700
Compact, specialty	1,254	550
Intermediate, regular	1,486	300
Intermediate, specialty	538	100
Full size	900	0
Luxury, regular	489	215
Luxury, specialty	154	70
TOTAL	6,770	3,350
1995		
Subcompact, regular	1,000	1,400
Subcompact, specialty	80	100
Compact, regular	950	700
Compact, specialty	1,300	594
Intermediate, regular	1,530	300
Intermediate, specialty	550	123
Full size	900	0
Luxury, regular	500	250
Luxury, specialty	170	86
TOTAL	6,980	3,553
2000		
Subcompact, regular	850	1,400
Subcompact, specialty	99	100
Compact, regular	980	720
Compact, specialty	1,350	600
Intermediate, regular	1,530	320
Intermediate, specialty	600	150
Full size	950	0
Luxury, regular	500	250
Luxury, specialty	180	100
TOTAL	6,949	3,640

Overall market segmentation is not likely to change dramatically.

The outlook is for a slight "richening" of the market, with cars shifting from regular into higher-priced specialty classes.

The domestic Big 3 are seen as maintaining dominance in the full-size segment but losing share in intermediate and luxury segments.

U.S. LIGHT-TRUCK MARKET SEGMENTATION

(Units in Thousands)

Year/segment	Domestic	Import
1990		
Compact pickup	675	600
Regular pickup	1,300	0
Compact van	700	55
Regular van	500	10
Compact utility	530	210
Regular utility	200	3
TOTAL	3,905	878
1995		
Compact pickup	700	625
Regular pickup	1,330	0
Compact van	789	80
Regular van	500	10
Compact utility	550	220
Regular utility	210	3
TOTAL	4,079	938
2000		
Compact pickup	710	630
Regular pickup	1,350	0
Compact van	845	100
Regular van	500	10
Compact utility	575	225
Regular utility	211	3
TOTAL	4,191	968

Forecasts indicate there will be no dramatic shifts in the light-truck segment of the market in the 1990s.

The trend from regular van and utility vehicles toward compact-size vehicles will continue. However, this appears to be a swing of only 2 to 3 percentage points during the next 10 years.

One trend that shows a good chance of developing is establishment of imported vehicles — both Asian and European — in the regular van and utility markets.

Japanese manufacturers should not be discounted from complete and competitive participation in the U.S. light-truck market.

WORLDWIDE PASSENGER CAR PRODUCTION

(Units in Millions)

Manufacturer	1990	1995	2000
GM	6.5	6.5	6.5
Ford	4.0	4.1	4.2
Toyota	2.8	2.9	3.0
VW	2.6	2.6	2.5
Nissan	1.9	2.0	2.0
Peugeot/Citroen	1.7	1.7	1.7
Renault	1.6	1.6	1.6
Fiat	1.6	1.6	1.6
Chrysler	1.4	1.3	1.3
Honda	1.3	1.4	1.5
Mazda	0.8	0.9	0.9
Daimler-Benz	0.6	0.6	0.6
Mitsubishi	0.6	0.6	0.6
BMW	0.4	0.4	0.5
Volvo	0.4	0.4	0.4
Hyundai	0.5	0.5	0.5
Rover Group	0.4	0.4	0.4
Suzuki	0.3	0.3	0.3
Fuji (Subaru)	0.3	0.3	0.3
Isuzu	0.2	0.2	0.2
Alfa Romeo	0.2	0.2	0.2
Daihatsu	0.1	0.1	0.1
Saab-Scania	0.1	0.1	0.1
Daewoo	0.05	0.06	0.07
Porsche	0.05	0.05	0.05
Other	0.05	0.08	0.1

As engineering and manufacturing technology is transferred throughout the world, more countries and more new manufacturers will launch or accelerate assembly operations.

As a result, comparatively rapid growth is forecast for newly industrialized countries such as the the Soviet Union, the People's Republic of China and Taiwan.

At the same time, steady growth of automotive markets is expected to take place in developing industrialized countries, as they establish their own automotive industries.

WORLD TRUCK AND BUS PRODUCTION

(Units in Millions)

Manufacturer	1990	1995	2000
GM	1.90	2.00	2.10
Ford	1.90	1.90	2.00
Toyota	1.00	1.10	1.10
Chrysler/Jeep	0.80	0.80	0.90
Nissan	0.70	0.70	0.70
Mitsubishi	0.60	0.60	0.60
Suzuki	0.60	0.60	0.60
Daihatsu	0.50	0.50	0.50
Mazda	0.40	0.40	0.40
Isuzu	0.40	0.40	0.40
Fuji	0.40	0.40	0.40
Renault	0.30	0.30	0.30
Peugeot-Citroen	0.30	0.30	0.30
Daimler-Benz	0.20	0.20	0.20
Honda	0.20	0.20	0.20
Fiat	0.20	0.20	0.20
VW	0.20	0.20	0.20
Rover Group	0.10	0.10	0.10
Kia	0.10	0.10	0.10
Navistar	0.08	0.08	0.08
Hino	0.06	0.06	0.06

The world outlook for truck and bus production is one of slow growth at best in the 1990s.

Forecasters see no dramatic shifts among the world's major truck producers. However, Chrysler Motors, as a result of its acquisition of the Jeep vehicle business, is expected to enjoy the biggest volume increase on a percentage basis. Gains are also forecast for Toyota.

General Motors and Ford Motor Co. are seen as maintaining their industry-leading volume positions throughout the next decade.

Maintaining their production volumes through the decade: Nissan, Mitsubishi, Suzuki, Daihatsu, Mazda, Isuzu, Fuji, Renault, Peugeot-Citroen, Daimler-Benz, Honda, Fiat, Volkswagen, Rover Group, Kia, Navistar and Hino.

Source for tables and projections is the University of Michigan's Delphi V report.

A time for decision on automation

Spend billions more or use that money for other purposes?

The 1980s have seen major commitments by the U.S. motor vehicle industry, in terms of both capital investment and effort, in the area of programmable automated manufacturing.

Led in particular by the pervasive campaign of General Motors to re-automate the majority of its facilities, the auto industry as a whole has invested tens of billions of dollars in new automation equipment and related plant expenditures since 1979. The goals of that enormous outlay have been stated many times in a variety of ways. But the overriding purpose has been constant: To achieve world-class quality levels in U.S.-based motor-vehicle manufacturing and retake the competitive initiative in at least U.S. domestic, if not world, vehicle markets.

Whether the investment in programmable automated manufacturing has, even initially, paid off is a major question throughout the industry. The bulk of the outlays have been made by the original-equipment manufacturers and have been concentrated in robotics applications such as vehicle body, stamping, welding and painting, material handling and relatively simple applications of computer-assisted design.

The industry now faces a decision regarding a new wave of implementation in the 1990s. Should additional investments be made in advanced manufacturing technology (billions more) that will provide the needed integration and applications to make the initial investments pay off? Or should capital spending in the next 10 years be concentrated on product and market development and acquisitions?

Major criticisms of automation investment to date include charges that the new equipment was installed without regard to the requirements of new product, that it has contributed little to the flexibility of operations, that it costs too much in an environment of shifting production schedules and that it does not link up adequately to the needs of product designers or suppliers.

Other technical reservations include the reliability and compatibility of a bewildering variety of programmable systems that are rarely integrated in a manner that allows the achievement of the performance goals set out with such initial optimism in the early 1980s.

On the other hand, proponents of programmable automated manufacturing have underscored the impressive productivity gains made in the applications where it has been fully adopted. They point out that the implementation of the new automation is far from over. Although the "new" applications may indeed resemble the dedicated automation technologies of the past, there are important existing and potential differences.

The new automation is primarily electronic both in terms of its power source and controlling mechanisms. It is also truly programmable — at least potentially — and can be adjusted quickly for new applications, especially in comparison to older manual technologies.

The major remaining features required to achieve the full promise of programmable automated manufacturing involve the integration of current technologies with each other (computer integrated manufacturing), the development of flexible machining capacity in response to market developments and the critical linking of flexible manufacturing to the design and procurement process or computer-assisted design/computer-assisted manufacturing.

Pressing future developments that obviate the need for computer-assisted design/computer-assisted manufacturing include the following:

- The proliferation of distinct vehicle market segments, each requiring dedicated platforms, drivetrains and other components and frequently using different materials.

Sales volumes for the new vehicle markets will be considerably smaller than was the case for the older, broader markets. The ramifications of the "nichification" of markets for the scale and structure of motor-vehicle manufacturing are numerous and serious indeed for U.S. producers.

Current facilities can survive in the future only by attaining flexibility in production or the ability to produce a variety of components or vehicles of one type or many types with the same equipment and labor force at efficient cost levels.

- The life of a typical automotive design will be considerably shorter as "design turnover" increases. It has been estimated that a typical major Japanese competitor can develop an essentially new platform vehicle in three to four years. Since Big 3 platforms are expected to last eight to nine years, the competition can match any U.S. investment at a lag of only three years.

Faster design turnover also means more rapid response to changes in consumer preferences for components and vehicles. Process technology that can be set up quickly or converted to new programs/designs can save literally billions of dollars in tooling and other costs as well as reduce the critical leadtime to change in the market.

- Although the gap between U.S. and Japanese labor costs and productivity continues to shrink, new competitive challenges based primarily on drastically lower levels of labor compensation in newly industrialized economies with developing auto manufacturing sectors are emerging and will emerge in the 1990s.

To the extent that U.S. production remains onshore, continued advances in labor productivity and unit labor cost must be achieved to maintain competitiveness. Productivity increases must be effected at every level in the integrated stages of auto manufacturing. And they must necessarily be attained by suppliers as well as OEMs if the new technology is to have any effect on overall vehicle cost.

The proportion of auto manufacturing facilities that are using or plan to use computer-assisted design/computer-assisted manufacturing in operations may not be impressive. The Bureau of Census of the U.S. Department of Commerce recently completed a survey of 10,000 U.S. manufacturing establishments on their current and future use of programmable automation.

Table 1 contains select results for the portion of the study dealing with establishments in transportation equipment manufacturing (including aircraft plants).

Although 58 percent of facilities expected to be using computer numerical control equipment and almost 43 percent expected to be using computer assisted design or engineering within within five years, only 37 percent expected to be using "computer-aided design output to control manufacturing machines" in the same period.

Only 30 percent of responding establishments reported the current use or planned use within five years of "computer aided design output in procurement activities."

In other words, fewer than two-thirds of transportation equipment manufacturing facilities have any plans or expectations concerning the use of computer-assisted design/computer-assisted manufacturing in the foreseeable future.

The potential effect of computer-assisted design/computer-assisted manufacturing on operational efficiency may be great indeed. This author recently completed a manufacturing study for the Economic Development Administration of the U.S. Department of Commerce regarding the productivity effects of five types of programmable automation in five U.S. manufacturing industries.

Of the 110 complete cases collected in the study, 37 were of robotics use in U.S. assembly, component and stamping facilities. That subset of auto robotics users is compared to 35 computer numerical control equipment cases in the tool and die industry (makers of automotive dies and models for the most part), 20 cases of controller use in the iron and steel foundry products industry and 19 users of computer-assisted engineering in the industrial electrical equipment industry.

In comparing major subsamples on the effectiveness of the new technology, the most striking comparison was between automotive robotics and computer numerical control equipment use in tool and die shops. The median increase in the throughput rate (including setup and maintenance) for a robotics application in a motor vehicle plant was zero percent.

In other words, robotics had no appreciable effect on the auto plant's ability to produce. In contrast, job shops that replaced older manual machine tools with computer numerical control equipment reported a median increase in the throughput rate of 55 percent. When the computer numerical control equipment was directly linked to computer-assisted design, the effective median increase was an astounding 308 percent.

In other words, the same facility could then produce three times the level of output as before or, since the major benefit was a drastic reduction in setup time, handle three times the product diversity as with older, manual equipment. The effect of that technical leap connected to computer-assisted design/computer numerical control equipment, a form of computer-assisted design/computer-assisted manufacturing, is to reduce capital costs by almost two-thirds in a diverse product mix environment.

Automotive robotics did not achieve that level of effectiveness, the case studies reported, either because the technology was implemented as dedicated automation or because the flexibility of the equipment was wasted. Even when the equipment was capable of flexibility, it was not connected to design or was not given a range of products to produce.

Robotics certainly affected the level of labor use in automotive applications. Automotive robotics users experienced a median increase in labor productivity of almost 390 percent and a median reduction in unit labor cost of 83 percent. Those results exceed those for straight computer numerical control equipment in machining shops, yet are actually surpassed by computer-assisted design/computer numerical control on both counts.

It should be remembered that labor cost reductions at any stage of auto production quickly reach an effective limit. For example, if all labor use were eliminated in the final assembly of motor vehicles, unit costs would fall less than 12 percent. Computer-assisted design/computer-assisted manufacturing's special promise lies in its potential to reduce capital, inventory and design costs as well as improve the effectiveness of the procurement of components and parts from independent suppliers.

The special challenge of the 1990s is to make automotive automation work in the same fashion as the computer-assisted design/computer numerical control cases described above. The most pressing needs are in component manufacturing plants that perform large-scale machining operations. Faced with a wider range of transmissions, engines and other systems in the 1990s, those plants must either acquire effective flexible machining through computer-assisted design/computer-assisted manufacturing or watch many of their operations be outsourced to smaller independent facilities.

The transition to effective computer-assisted design/computer-assisted manufacturing in the auto industry of the 1990s carries a high cost and much risk. Money for investment will be borrowed at the expense of product development programs. Full-scale integration will be difficult since every component of the process must work perfectly in unison, as a number of model "factories of the future" have discovered.

Suppliers must cooperate and participate at every stage of the production chain or the benefits will be limited. The necessary training and cooperation of labor must also be present. It has also been pointed out that the Japanese do not rely to any great extent on that form of technology. Automation is a lagging alternative for them, the last options to be implemented.

The Japanese style of product diversity is characterized by high organizational and financial commitments to product innovation within well-defined product areas. Whether the computer-assisted design/computer-assisted manufacturing alternative represents another American style, simple "techno-fix" to a complex problem or an actual climb to a higher plateau of technical efficiency is a question that will certainly be answered in the decade to come. ■

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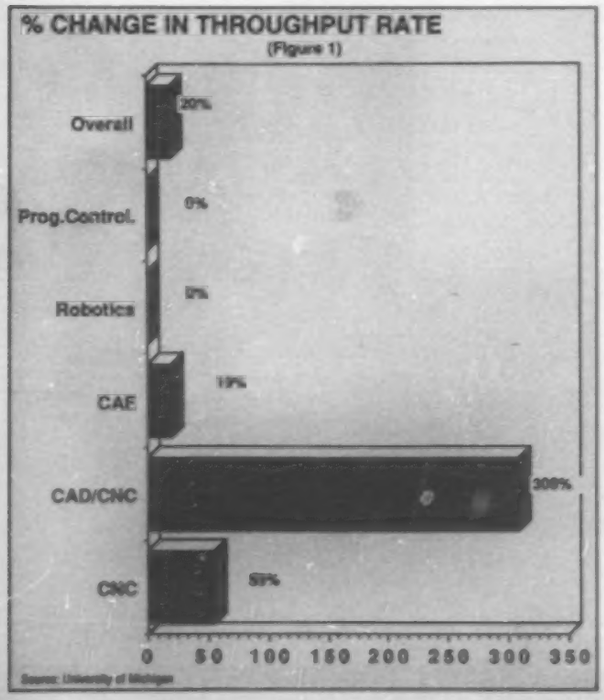
ESTIMATES OF TECHNOLOGY USE

Automotive technology	Percent using now	Percent planning to use in 5 years	Total percent using in 5 years
CAD/CAE	39.9	18.2	58.1
Pick and Place Robotics	10.4	11.4	21.8
Other Robotics	10.5	10.7	21.2
CNC	37.3	6.6	42.9
CAM, CAD/CAM	16.6	20.4	37.0
CAD/Procurement	12.8	17.4	30.2

Source: Manufacturing Technology 1988, SMT(88)-1, Current Industrial Reports, U.S. Department of Commerce, Bureau of the Census, May 1988.



'Threshold' of revolution

Technology, environmental concerns affect auto materials

The last decade has been a period of profound transition for the North American automotive industry. Tough international competition and fast-paced technical developments, coupled with challenging energy and environmental concerns, have fostered significant changes in our approach to selecting automotive materials. Industry planners are confronted by a host of critical issues as they choose materials for their future products. Market forces, commodity prices, manufacturability, design experience, existing facilities and new technologies are just a few of the considerations influencing these decisions. There is little question that we are on the threshold of an automotive materials revolution.

Even as new materials enter the picture, there are dramatic improvements in the production and processing of the more traditional automotive materials. One of the hallmarks of this revolution is the literally ferocious competition between candidate materials in a host of applications, ranging from plastic versus steel in body panels to aluminum versus copper in radiators. Over the long term, few components are restricted to a given material, and the sheer size and potential of the automotive market insures that today's winners cannot rest comfortably, assured that their current success will continue.

While it is difficult to predict with certainty the future of automotive materials, the University of Michigan Delphi Forecast provides a degree of insight into industry experts' beliefs about future materials. The Delphi method is a systematic, iterating method of forecasting based on independent input from a panel of [illegible]. We carefully select panelists from both the automotive manufacturers and their suppliers. The current Delphi V Forecast, the fifth in our series of biennial studies of automotive trends in technology, materials and markets, provides a consensus view of the future to the year 2000 through the eyes of over 300 industry leaders. We have delayed publication of the Materials volume of Delphi V to permit consideration of the effects of possible increases in CAFE mpg requirements on future materials, so all data presented here are from the general Technology forecast volume.

The materials future promises to be exciting and, in some respects, quite different from that envisioned by forecasts made earlier in the decade. A significant part of this change in expectations can be attributed to a substantial lowering of anticipations for future energy prices over the course of the U-M Delphi surveys. Fuel prices, based on the current Delphi survey, are expected to increase modestly over the next decade, and panelists have dramatically lowered their expectations of future fuel prices compared to earlier surveys. This sets the stage for shifts in many material forecasts.

In addition to fuel prices, panelists have changed their expectations for future passenger car weight and size. The consensus view is that downsizing has largely run its course and that, unless CAFE is increased, future weight reduction will be very modest. The Delphi panelists believe that if future fuel economy requirements are increased, the most significant areas for efficiency improvement are the powertrain, followed by weight reduction. Concerning total vehicle weight, our vision of the future has changed rather sharply in a fairly brief period of time. Steel will continue as the dominant automotive material, but there will be substantial use of cast iron, plastics in a variety of forms, and aluminum. Future increases in CAFE standards would probably increase both plastics and aluminum use, at the likely expense of steel and cast iron.

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Body/Chassis

The car body is perhaps the major arena of the plastics versus steel competition. With minor exceptions, exterior panels of North American-produced cars have traditionally been made from low carbon steel. This is likely to continue, despite the introduction of several plastic-intensive vehicles such as GM's Corvette and APV; however, various polymer-based materials are expected to begin making significant inroads, particularly in the non-integrated body panels. While growth in plastics is significant, it is considerably less than envisioned just two years ago in our Delphi IV forecast. This may be partially due to slower than anticipated development in plastics and plastics processing technology, but is probably more due to the considerable progress made by the steel and automotive industries in recent years, including improvements in quality, product design, corrosion protection, die making and stamping plant operations.

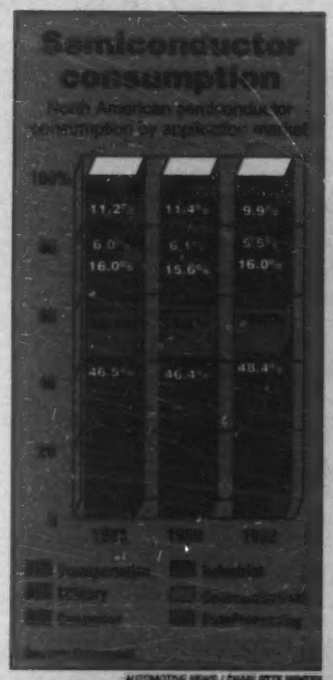
The forecast calls for the integral body frame passenger car structure to continue its dominance in the upcoming decade, although a small but significant fraction of vehicles will likely use separate body frame and space frame designs. Steel, in the opinion of our Delphi panelists, will be used in most future body/frame structures through the year 2000, although the role of both aluminum and polymer based composites is expected to expand. Since aluminum and composites are both near the beginning of their learning curves, intense competition will continue and expand. Material selection decisions in both the body exterior and structural areas will continue to depend on a host of actors including commodity prices, developments in processing technology, design knowledge, existing capacity, supply considerations, field repair, recycling vehicle systems issues, quality considerations, regulatory trends and customer perception of value.

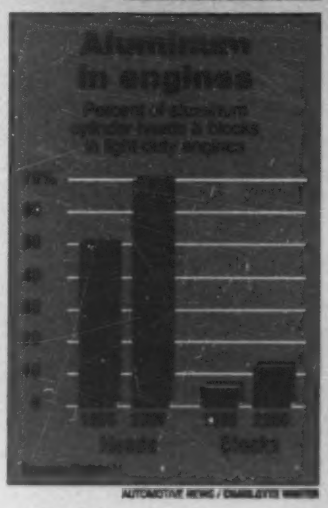
Powertrain

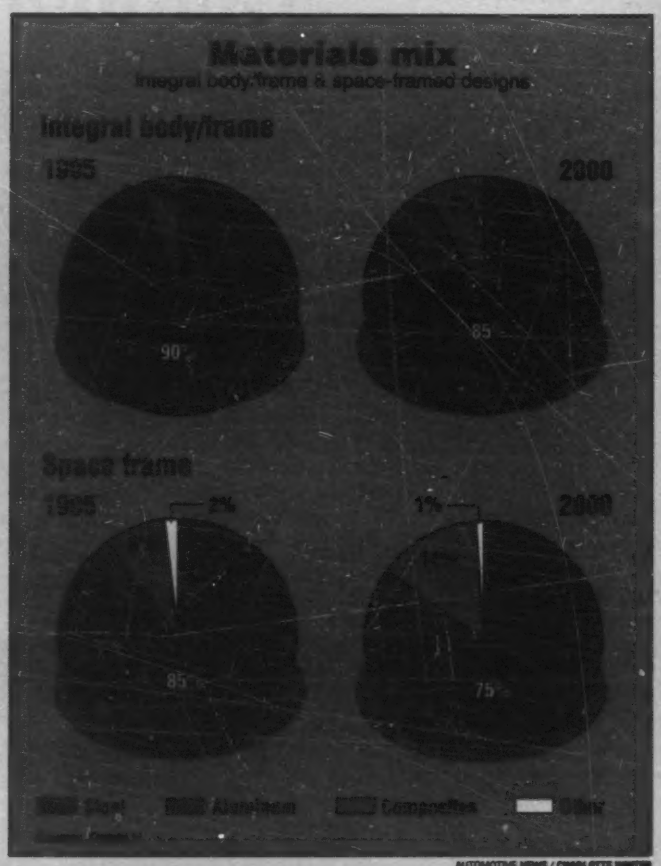
A number of exciting technical and material developments are anticipated in the engine and drivetrain. Increased demands for performance, fuel economy, reliability, durability and overall "World Class" cost and quality are driving engine designers to improve the entire powertrain. Panelists anticipate the fundamental redesign of a major fraction of North American-produced engines over the next decade. Manufacturing precision is greatly increasing, and a significant number of future powertrains will employ high-tech features such as double overhead cams (DOHC), 4-valve cylinders and integrated, electronic engine/transmission control. Aluminum use is expected to expand significantly in cylinder heads and somewhat more modestly in engine blocks. Panelists expect most aluminum blocks to continue use of cast-iron sleeves.

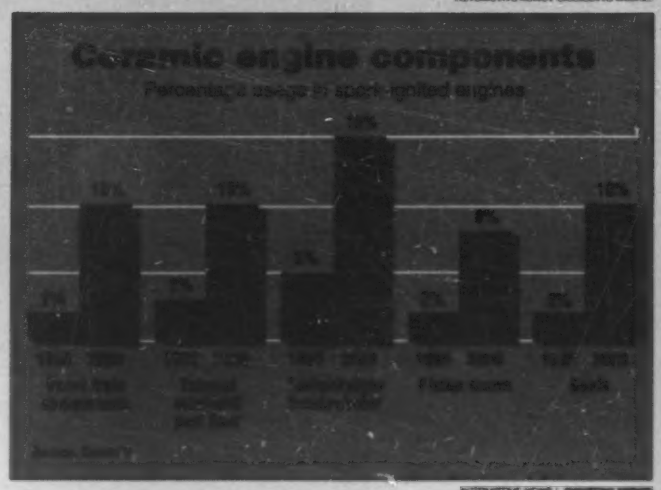
Panelists expect that polymers will achieve modest but important application in several engine components, while ceramic materials appear ready to move from the research laboratory into tomorrow's engines in a few selected applications. However, the complete ceramic engine is not yet on the near-term, or perhaps even the long-term, horizon. Although the primary reasons for ceramic applications are mass and friction reduction and the control of engine heat, piece-cost, manufacturing considerations and reliability concerns remain major impediments to its increased application. A tightening of fuel economy and emission standards might well spur the further development of ceramic technology.

The choice of traditional materials for most engine components is far from fixed over the next decade in light of the growing emphasis on mass and friction reduction, particularly in moving parts. A number of technologies are competing for material selectors' attention.









INTEGRATED CIRCUIT CONSUMPTION
(millions of dollars)

Market	1990	1995	2002
Data Processing	6,805.8	7,491.8	11,417.8
Communications	1,864.2	2,194.1	2,937.8
Industrial	2,001.6	2,158.8	3,324.5
Consumer	750.2	843.9	1,114.1
Military	1,442.9	1,650.4	2,109.2
Transportation	653.3	707.9	1,202.6
Total	13,518.0	14,957.0	22,105.8

SOURCE: Dataquest

Besides ceramics, metal matrix composites is an emerging material technology with exciting potential. While still in the early stages of development, recent progress in this technology has been significant.

This list of key representative engine components and candidate materials illustrates the broad scope of the competition:

Connecting Rod: Cast iron, steel, aluminum metal matrix composites.

Intake Manifold: Cast iron, aluminum, polymer/polymer-based composites, magnesium.

Oil Pan: Steel, aluminum, polymers, metal-plastic laminates, magnesium.

Corrosion

Significant progress is being made in corrosion protection. One measure of this is in the number of years that elapse before corrosion penetrates exterior panels. The Delphi V panelists forecast an elapsed time of eight years by 1995, lengthening to 10 years by the year 2000. Much of this progress can be attributed to substantial increases in steel's corrosion resistance, due, in part, to the use of a two-side coated, galvanized steels, improved paint and ▶

scaling systems, better design, and enhanced manufacturing process control.

Recyclability

The issues of solid waste and materials recyclability are becoming more important in the design, production, and ultimate retirement and disposal of the vehicle. While cost remains an impediment to increased use of plastics, environmental concerns also pose significant barriers. A decisive majority of Delphi V panelists (65 percent) believe it essential that the automotive industry develop or improve the recyclability or reclaimability of its products. These issues should be considered as an integral part of the vehicle design process. Furthermore, a significant 16 percent of the panelists expect some form of legislative activity enforcing recyclability/reclaimability within the next decade. We would hope the industry will seize the initiative on this issue. There does not appear to be a fundamental recycling problem for present and future automotive materials, but considerable effort is required on the part of some segments of the industry to meet this developing challenge.

Summary

It is clear that the automotive materials area is experiencing revolutionary development and progress. As the industry sharpens its focus on total customer satisfaction, materials will play an increasingly important role. There appears to be lessened enthusiasm for technological development for technology's sake, and more emphasis on value delivered. New and developing automotive materials are achieving a level of application that ensures the production of passenger cars that could only have been a dream a few years ago.

This is not a time for complacency. The automotive materials industry faces a future of not only unprecedented challenge, but also significant opportunity. As most of the world's automotive manufacturers achieve true parity in terms of traditional customer value factors, material-related issues may tip the balance in the customer's selection.

Regardless of who the winners and losers are in the "Materials Olympics," the true benefactors of the competition will be the consumer. ■

AUTOMOTIVE NEWS / CHARLOTTE WATSON

In electronics, the word is 'smart'

New chips 'sense,' and they take action on what they've sensed

Smart power. Smart chips.

Those are among the most exciting new phrases in the lexicon of emerging automotive electronics technology these days.

They're being heard in descriptions of chips used in such hot items as automatic suspensions, traction control systems and other real, promised or pipe-dream wonders of the world of automotive electronics.

In virtually all prognostications about the world of automotive electronics in the 1990s and beyond, smart chips serve a keystone function.

A smart chip is made up of sensing components and components that take action based on what's been sensed.

Because smart chips are available, electronics engineers have been able to trim dramatically the size of electronic devices to fit them into the high-cost real estate under instrument panels and in black boxes under the hood. Also, in electronics, smallness has come to be equated with low cost, reliability and speed.

"It's become a term too loosely used, but 'smart power' does catch the sense of something very important," said Edward Whitaker, staff engineer, advanced development at Delco Electronics Corp. in Kokomo, Ind., part of GM Hughes Electronics Corp.

"Smart power, although it's loosely defined, means combining linear and digital and power — combining different circuit functions and different technologies on the same chip of silicon. It's power plus control. But there's a million varieties, depending on manufacture, because they all have different approaches," he said.

"In the old days, we'd buy one of these, one of those and one of them and maybe drive a motor.

"When you put all those functions on one piece of silicon, you have what's referred to as smart power.

"With smart power, you save space. You make smaller systems possible because you don't need as many components. You also can do things you couldn't do before. For instance, with something like a power mirror, there isn't room for a big box. You need one chip," Whitaker said.

"There absolutely is an increase in reliability. You don't have all the interconnections, the solder connections, all the problems of sorting, handling and inventory."

Quality improves when smart chips are manufactured because only one chip is handled and bonded. There may be about eight critical masking steps involved in the making of a current chip (layers and diffusions) while smart power is more complex and might call for 18 critical levels, he said. He explained how smart devices have evolved as electronics in general have advanced.

"A typical system through the '60s, the '70s and into the '80s was discrete," he said. "That is, it had one specific function. Such a system might consist of a logic circuit that provided a signal to a tightly packaged device that was made to switch a particular amount of current.

"For example, the logic circuit would say, 'turn on,' 'turn off' or 'something's not right.' The second device, a transistor, would do the switching ordered by the logic circuit. Thus, there were two different parts making up one system.

"To make up a system, engineers might take a bipolar integrated circuit for linear functions and a MOS chip for digital functions and then add a power device that would deliver amps and drive a motor," Whitaker said. Thus, three different types of parts made up a system.

Smart power will allow engineers to build controls into the devices they control.

For example, the control chip for a windshield wiper motor can be mounted directly on the motor instead of nearby. "If you have one chip, you can put it in the motor. If you have to build it up of a number of components, it gets pretty big and won't fit," Whitaker said.

He said the same principles hold true in multiplexing, a system of sending power for more than one system over the same electrical wires.

"When you have a wiring harness in the door, you don't want 52 wires running into the door; you want ... You put some electronics in the door that get a signal and open the door locks or open the windows. The box can't be too big. You want something that's small and light. If you can put it all on one chip it can go right in the door," Whitaker said.

Toshiba of Japan recently completed development work on an intelligent power switch that allows a microprocessor to drive motors, solenoids, lamps and other loads directly. The switch contains diagnostic functions and also has built-in overload protection.

Chrysler Motors is using a smart chip in what it calls an "electronic traffic cop" for the advanced vehicle data communications network in the Chrysler New Yorker and Dodge Dynasty luxury models.

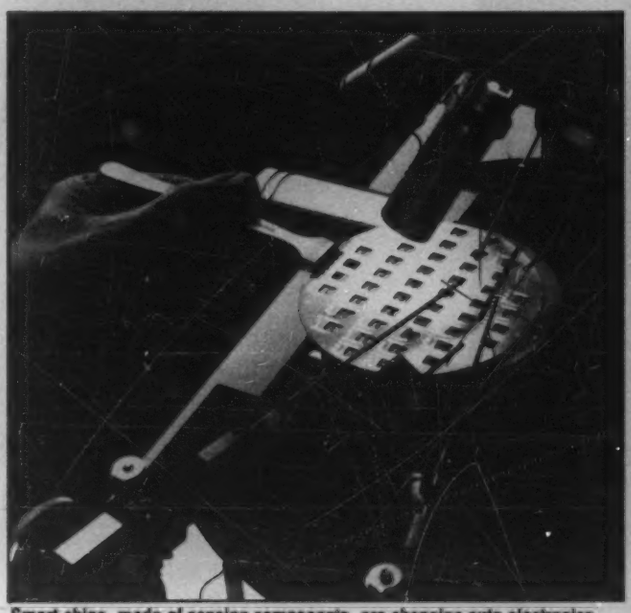
A chip is the heart of the multiplex system that directs the flow of data among a network of microcomputers. The chip, put in place initially in the 1988 models, is the first in the industry that met SAE requirements for data communications multiplexing, Chrysler Motors said.

In its role as a "traffic cop," one of the chips is installed in each of the microcomputers used in the New Yorker and Dynasty models. It allows the microcomputer to share information and assign priorities to messages seeking to access the vehicle's data network.

Called the Chrysler Collision Detection Data Network, the system interconnects the engine controller, body computer, overhead console display, trip computer and engine compartment sensor modules. It uses single twisted pairs of wire instead of dedicated pairs of wires. Without the system, dedicated wires would be required to connect each module or computer to every other module or computer.

The Cadillac Allante includes a small amount of multiplexing of the hybrid type rather than smart power. A hybrid assembly usually consists of a ceramic substrate on which conductors and resistors are printed and on which chips are mounted and connected, Whitaker said.

Candidates for application of smart chips include anything that has a motor or a solenoid, Whitaker said. Those possibilities range from fuel injector drivers to solenoids to lock the trunk and electric motors to raise a car's windows or antenna or move its seats.



Smart chips, made of sensing components, are changing auto electronics.

"Not every situation calls for smart power," Whitaker cautioned. "Sophisticated technology is required. It can be expensive. And, sometimes you shouldn't try to put everything on one chip. Systems designers have the option in partitioning a system to use multiple chip solutions or single-chip solutions.

"The biggest thing we're finding is that we are more frequently merging technologies on a chip. That's another merging of technologies. We get more done on one piece of silicon.

"We used to build systems with 1,000 transistors on a circuit board, and there was a specific reliability of that product. If you put all those transistors on one chip, there is a massive improvement in reliability because it's all made with automation," he said.

"The biggest problem we have is convincing people that the hurdles to overcome and the difficulties in getting the job done are worth it. We're almost in a situation like the one Thomas Edison found himself in when he invented the light bulb. There were no generators in cities, no power stations, and everyone had gas piped right into his home."

Whitaker continued, "Multiplexing on a small scale is like that. There are traditional ways that work well. Careful consideration and planning are essential in deciding to use a new technology. For an example of a good candidate for multiplexing, look at a car door that today might have 50 or more wires running into it. Multiplexing, in this case, would consist of a master computer with a ground wire, a signal wire and a control wire routed around the car.

"Instead of 50 wires running into each door, there would be three. A smart circuit would connect to the signal wire and the chip would drive various loads like a lock, motor, cigaret lighter, crank or lamp."

George D. Aravosis, immediate past president of SAE and director of new technology development for Navistar International Transportation Corp., believes smart power chips are on the way to commercialization.

He said, "Even though we know a lot more than we did in the early 1970s, the commercial vehicle environment, which strongly influences successful application of electronic systems, encompasses a wide range of environmental conditions.

"Development of multiple wiring systems with modules containing smart power switches that combine a high-current electronic switch with control logic circuitry in one small package will aid in this area. Such chips are capable of switching large amounts of DC current using an extremely low control current," he said.

"The smart switch can replace numerous conventional electrical system components. With fewer electrical components, the overall reliability of the truck improves. The built-in logic circuitry of the smart switch provides an output that can be used to diagnose problems in the electrical system. The diagnostic capability offered by the smart switch means a vehicle that is easier to service," he explained.

Aravosis also said an electronic dash with real-time feedback is needed for owners/operators/drivers. On-board diagnostic devices for engines and brakes would assist in self-maintenance practices. The payback from those information devices is knowing where the money goes and showing areas of potential savings.

Many fleet operators and owners feel that if trucks are designed and built correctly in the first place, they can get 600,000 miles from the truck before major problems will occur, he said. Such systems may move them closer to their million-mile-truck goal.

Timothy D. Leuliette, president of Siemens-Bendix Automotive Electronics, said recently, "Exciting new smart sensors are being developed in our new Integrated Silicon Sensor Laboratory in Newport News, Va.

"These silicon sensors will be capable of measuring a variety of automotive parameters and will close the technology gap between the highly developed information processing capability of the microcontroller and the relatively unsophisticated sensors currently feeding data into the electronic control unit." ■

Author Roger Rowand is an Automotive News staff reporter.

Big 3, Transplant 7

Domestic dominance wanes, but the worst may be over

It is 1999 and the American automotive industry is having a renaissance of sorts.

Having overcome the bleak days of restructuring and bullet-biting that cluttered the early '90s, the Detroit Big 3 and their new industry neighbors, the Transplant 7, have developed a new symbiosis. The transplants bolster their operations with captive sales to the Big 3. The Big 3, in turn, have inculcated more efficient production systems from the transplants, and widened profit margins by sharing overhead and development costs through joint ventures.

Having lost almost half of the entire North American market in the course of 25 years, Detroit is now reaping some rewards from a mammoth, decade-long campaign to open new plants, rebuild and retool vital older plants, close down marginal car lines, consolidate the production of diverse models, introduce new products and respond faster to consumer desires than ever before.

General Motors has adopted some of the ways of partners Toyota, Suzuki and Isuzu. Ford has learned from partners Mazda and Nissan, and Chrysler from Mitsubishi and Hyundai. Market share has stabilized, and the U.S. corporate triumvirate that produced 10 million passenger vehicles to mixed results seven years ago in 1992 is now selling 9 million a year with more encouraging margins.

The great industrial management reawakening of the 1980s has resulted in car plants that are more cost efficient and productive. U.S. factories are pumping out bigger numbers of cars and recreational vehicles, and annual U.S. vehicle sales, strengthened by population growth and more appealing sticker prices, are holding fast at 14 million to 15 million units a year. Stringent environmental legislation during the early '90s made vehicles lighter and more fuel efficient. New component technology has improved performance. Tougher competition has bred better product quality, better customer satisfaction at the retail level.

The domestic industry has bounced back from those fierce competitive blows of the 1980s, when new Japanese and Korean competitors sliced away at the market. Foreign-based car companies are now producing a once-unimaginable 4 million cars, trucks and vans a year in America. But half of that number is being sold by the Big 3 themselves.

American suppliers who, just 10 years before, were desperately fighting the incursion of offshore competitors have formed hundreds of new partnerships with Japanese firms to produce lower-cost, higher-profit components to both transplant and Big 3 customers.

Import levels have fallen from their peak of 3.2 million cars in the early '90s to about 2.5 million.

A rose-colored vision of days to come? Not necessarily, a number of leading U.S. auto industry analysts maintain. According to some, the climax to the dramatic power shift now in progress between domestic and offshore industry forces could come in the next decade. The outcome could be the industry renaissance described, or if circumstances continue on in their current trajectory, a gradual wresting away of market control from the U.S.-based companies. How well the American industry fares, some observers say, depends largely on how well the Big 3 and their key suppliers come to terms with the phenomenon at their doorstep — the transplants.

Author Lindsay Chappell is the chief of Automotive News' Mid-South bureau.

MAZDA MOTOR CORP.
U.S. vehicle sales 1989: 370,000
N. American vehicle production 1989: 200,000
N. American vehicle production 1992 (est.): 360,000
Plants:
● Mazda Motor Manufacturing (U.S.A.) Corp. (1987)
The Flat Rock, Mich., manufacturing plant is still in the first phase of production, building 200,000 cars a year. In 1990, the plant will yield 240,000 a year, including the Mazda 626 and MX-6, and the Ford Probe.

AUTOMOTIVE NEWS/JOE WILSSENS

The transplants have mastered the art of making gradual, minute, incremental labor-saving changes in production.

The 1980s passed like a kidney stone for many in the American auto industry. It was, in the final analysis, a decade of absolute change in which foreign competition cracked wide open every corner of the U.S. market bastion. As if in fast motion, the industry saw the wholesale acceptance of Asian-designed and engineered cars and light trucks among U.S. buyers, the mushrooming of a permanent retailing establishment for foreign manufacturers and the end to the presumption of American leadership in vehicle quality and technology.

Such was the atmosphere for the first decade of the transplant. Though West Germany's mighty Volkswagen AG had first opened a U.S. plant in the '70s to supply what would soon become a dwindling market for its low-cost, high-quality line, it was the Asian-based car companies' arrival in the '80s under a whole new set of circumstances that heralded the coming changes of the 1990s.

In sheer numbers, no one offshore manufacturer amounts to more than a small competitor in the U.S. market. American Isuzu, for example, sells about half the number of cars that Dodge sells of its Colt model. Compared to General Motors' inventory of plants and production volume, all the output of all the transplants combined still represents a minority share of the market. But the new facilities that overshadow the rural midwestern cornfields where they operate bode an uneasy future for the Big 3. The transplants are not so much succeeding by mastering the traditional U.S. car-production game. They are succeeding by playing under new rules. How well they absorb and excel at those new rules could determine which future they see.

In the brief span of eight years between 1981 and 1989, the Japanese car companies went from no U.S. production capacity to a total capacity of 1.5 million units a year. By 1992, the group's total North American capacity will reach 2 million. And by 1995, based almost entirely on existing plans, the number is likely to pass 3 million, representing a fourth of all North American production.

The question many in the industry now ask is: How much more can the transplants build? With immense capital at their disposal from a decade of strong earnings, and favorable yen-dollar exchange rates resulting from the economic summits of the mid-80s, the larger Japanese players could easily put more plant capacity in place during the coming decade. And undoubtedly, additional plans will be unveiled. But transplant expansion during the '90s will be affected by five key issues:

● Progress in U.S. foreign trade policies. As the U.S. attempts to pry open tightly controlled Asian markets to U.S. goods during the coming decade, one repercussion may be more transplant activity. Japan's leaders could easily respond to U.S. concerns over endless trade imbalances by discouraging the Japanese auto-exporting industry. The Japanese government has already asked automakers to refrain from constructing more auto plants in Japan, though the specific intent was to protect the industry from a domestic glut. Free market economics will dictate most of the allocation decisions of the coming decade, however.

It is now estimated that a transplant can produce a car at a $400 to $600 cost advantage over Detroit. The same car produced in Japan has only a $300 advantage after paying for importation. At the same time, the profit margin on a Japan-built car sold in Japan is greater than that on the same car exported and sold in America. Domestic tax changes in Japan in 1989 spurred an auto sales boom that the Japanese carmakers struggled to supply. It will clearly be in the imports' best interest to shift production for the U.S. market to U.S. sites in the future.

● More aggressive U.S. environmental policies. An apparent stall in the auto industry's ability to improve fuel efficiency in the late '80s did not sit well with many in Congress. As the decade closed, the Bush Administration, the EPA and a half-dozen congressmen were formulating plans to set new guidelines for fuel-efficiency improvements. Should the resulting legislation ask for large and quick increases in mileage averages, the producers of smaller, lighter, more fuel-efficient cars would enjoy a sales boom. Honda, Toyota, Nissan, Hyundai, Isuzu and others would have new impetus for expanding U.S. capacity.

● Further changes in the yen-dollar exchange rates. Although the economic community widely believes the yen has stabilized long-term in the range of 120-140 to the dollar, even a short-term drop could make real estate buying and capital expenditures in the U.S. market more appealing for the Japanese. The financial premise of the transplants themselves is to make production immune to currency fluctuations. But as long as U.S. capacity growth is desirable, the multinationals will look for opportune moments to invest.

● The vitality of the U.S. economy, including auto sales. Obviously, a major recession would throw the brakes on industrial expansion in most sectors, although investment funding from sources outside the States would remain somewhat impervious to a steep down-cycle here. But for the most part, new plant capacity will depend on sales growth. The transplants enjoy still another advantage in the event of a long-term economic shift, causing, for example, a demand shift to econo-cars. The transplant facilities are newer, and designed for flexibility to allow the companies to change product lines more easily.

● U.S. public attitudes toward foreign interests. By 1989, the Japanese Automobile Manufacturers Association was maintaining that whatever "anti-foreign" sentiment existed in the U.S. toward the Japanese car makers had, for the most part, dissipated.

But the issue remained evident in transplant objectives. Every transplant in the country is currently attempting to increase local purchasing of parts and local part production in order to increase their vehicles' domestic content — principally to assuage public resentment of their siege of the domestic industry.

Solveig Spielmann, chairman of International Business Counselors, a Washington, D.C.-based consulting firm on trade policies, agrees that consumer pressure against offshore manufacturers is not likely in the coming decade. But she acknowledges that the issue is tied to economics.

"It's possible that we could see more anti-foreign-investment public sentiment, but I don't believe the conditions exist for it," Spielmann says. "These are good times in the country. People want to work."

Not, apparently, a key factor in the transplants' future is the basic issue of market overcapacity. A general assumption underlies the segment's growth that Big 3 production, plus transplant production doesn't necessarily equal total industry demand. Transplant growth is taking place to serve the growing sales results of the transplant parent companies. If new transplant production capacity leaves the North American indus- ▶

TOYOTA MOTOR CORP.
U.S. vehicle sales 1989: 960,000 (est.)
N. American vehicle production 1989: 250,000
N. American vehicle production 1992 (est.): 500,000
Plants:
● New United Motor Manufacturing Inc. (1984)
A 50-50 joint-venture with General Motors, NUMMI supplies Toyota with 100,000 Corollas a year.
● Toyota Motor Manufacturing U.S.A. (1988)
The $800 million facility in Georgetown, Ky., can produce 200,000 units a year of the company's best-selling U.S. car, the Camry.
● Powertrain Plant (1989)
Toyota is spending $300 million to open a 4-cylinder engine plant adjacent to the Camry facility. By 1991, the plant will also be supplying many of the engine components, including pistons, valves and cylinder heads.
● Toyota Motor Manufacturing of Canada (1988)
The Ontario facility produces 50,000 Corollas a year.
● TABC Inc. of California (1974)
The Long Beach, Calif., plant produces pickup truck beds. Plans to expand the operation were stymied by U.S. industry opposition in 1988.
● NUMMI 2 (Proposed: 1991)
Toyota, independently of GM, plans to open a second line at NUMMI to produce approximately 100,000 small pickups a year.

NISSAN MOTOR CO.
U.S. vehicle sales 1989: 678,000
U.S. and Mexican vehicle production 1989: 360,000
U.S. and Mexican vehicle production 1993 (est.): 650,000
Plants:
● Nissan Motor Manufacturing Corp. U.S.A. (1985)
The Smyrna, Tenn., facility currently yields 220,000 Sentras and light pickups a year. By 1992, the plant will expand capacity to between 400,000 and 440,000 units to include production of an as-yet undesigned Stanza-level sedan.
● Nissan Mexicana, S.A. de C.V. (1966)
Three Mexican plants now produce approximately 120,000 Tsurus (Sentras) a year, as well as engines and various stamped components, but will probably expand production to 200,000. Engines have been exported to both Japan and the U.S., and vehicle exports have reached about 26,000.
● Avon Lake Plant (under construction: 1992 est.)
Nissan will develop a new minivan, the VX54, in conjunction with Ford Motor Co., which Ford will assemble in Avon Lake, Ohio. Nissan will derive approximately 50,000 units a year from the project.

FUJI HEAVY INDUSTRIES
U.S. vehicle sales 1989 (est.): 150,000
N. American vehicle production 1990: 60,000
N. American vehicle production 1995 (est.): 120,000
Plants:
● Subaru-Isuzu Automotive (1989)
The last of the major Japanese carmakers to build in the U.S., Fuji/Subaru will receive half of the joint venture's 120,000-vehicles-a-year output. In the early to mid-1990s, the Lafayette, Ind., plant will boost capacity to 240,000 units a year.

HYUNDAI MOTOR CO.
U.S. vehicle sales 1989: 250,000
N. American vehicle production 1989: 10,000
N. American vehicle production 1991: 100,000
Plants:
● Hyundai Auto Canada
The Bromont, Quebec, facility will assemble 100,000 Sonatas by 1991, mostly for shipment to the U.S. A separate but adjacent stamping plant was scheduled to open in late 1989 to serve the operation.

MITSUBISHI MOTORS CORP.
U.S. vehicle sales 1989: 130,500
N. American vehicle production 1989: 45,000
N. American vehicle production 1991 (est.): 120,000
Plants:
● Diamond-Star Motor Manufacturing (1988)
A 50-50 joint venture with Chrysler Corp., which owns 12 percent of Mitsubishi, Diamond-Star produces 120,000 Mitsubishi Eclipses and Mirages a year.

SUZUKI MOTOR CO.
U.S. vehicle sales 1989 (est.): 29,000
N. American vehicle production 1989: 10,000
N. American vehicle production 1992 (est.): 100,000
Plants:
● CAMI Automotive (1989)
The Ingersoll, Ontario, plant, a 50-50 venture between Suzuki and GM, has a capacity of 200,000 utility vehicles a year, divided evenly between the parent companies.

ISUZU MOTORS
U.S. vehicle sales 1989: 120,000
N. American vehicle production 1990: 60,000
N. American vehicle production 1995 (est.): 120,000
Plants:
● Subaru-Isuzu Automotive (1989)
Isuzu's 49 percent control of the Indiana facility will net it 60,000 pickups and sport-utility vehicles a year as production matures in 1990. Plans to double the capacity are indefinite, but forecast for the mid-1990s.

HONDA MOTOR CO.
U.S. vehicle sales 1989: 800,000
N. American vehicle production 1989: 420,000
N. American vehicle production 1992 (est.): 700,000
Plants:
● Honda of America Manufacturing/ Marysville (1982)
The first Japanese transplant facility, Honda of America Manufacturing in Marysville, Ohio, produces 360,000 Accords and Civics a year, and also builds motorcycles and provides engineering support to Honda facilities across the continent.
● East Liberty Plant (1989)
The new 150,000-unit-a-year plant will initially produce 4-door Civics, but that vehicle will be replaced in late 1990, and the company is already considering a second vehicle at this Ohio site.
● Honda of Canada Manufacturing (1986)
The Alliston, Ontario, plant may be expanded from 50,000 Civics a year to 80,000 in 1990. Most production is for the Canadian market, although Honda is able to ship more freely between Canada and the U.S. now by meeting the domestic content conditions of the Free Trade Pact.
● Honda de Mexico (1988)
Honda officials have said there are no vehicles in the Guadalajara, Mexico, facility's future. For now, the plant will build replacement parts and body panels for Honda vehicles and motorcycles.
● Anna Engine Plant (1985)
By 1991, Anna will yield 500,000 engines a year for both the Accord and Civic. Plans are for the facility to produce all the engines needed for Canada, East Liberty and most of Marysville.

try as a whole with too many assembly lines in action, the assumption goes, it will be the older, less efficient and less flexible operations that will feel the pressure. In other words, it will be the Big 3, whose individual market shares have slipped for the past decade and will logically slip during the coming decade.

The result could be painful. If, as the automotive market research firm Autofacts calculates, total U.S. production capacity grows to 15.6 million by 1993, excess capacity could reach 5.3 million units, based on current utilization rates and sales levels. Autofacts contended that by the early 1990s, 10 domestic plants would be closed as a result of the transplant boom. General Motors would face closing five, Chrysler three and Ford two, the firm speculated.

Plants open and close. GM itself rendered 10 plants inactive between 1987 and 1989, and opened or reopened three others. In 1990, GM is scheduled to open one of the biggest projects in its history, the Saturn plant in Spring Hill, Tenn. Interestingly, Saturn is predicated upon transplant principles. Stamping and parts-making are done at the assembly site. Factory job classifications are reduced to only a few levels. Workers are given more power to make on-line decisions on production quality.

An industry rule of thumb holds that American market demand increases by the need for one new assembly line a year. By that measure, the capacity crisis of the '90s could be less critical than the numbers would suggest. The Detroit carmakers are already eyeing various of their older plants and less promising vehicles to idle. If capacity of 1 million units is eliminated over a five-year period, when 2 million units of new, more efficient capacity is being added, the industry will roughly break even. The key difference is that older Detroit inventory will replaced by newer transplant inventory.

Clearly, the industry shift is not inherently transplant versus domestics, but rather old versus new. Not only are the transplant structures themselves newer, for the most part. Their systems of production have honed away older inefficiencies, such as costly work rules and unnecessary middle managers. The newer plant hardware allows for faster die changes and more expedient troubleshooting. Computer-choreographed delivery systems avoid the typical line shutdowns that plague older plants when suppliers stumble, and also cut overhead by eliminating plant warehouse space.

"The age of a plant is a very crucial issue in any industry," comments Thomas O'Grady, president of the industry consulting firm, Integrated Automotive Resources. "It's simply difficult to produce competitive products from an older facility that was built to operate under a different production system."

Newer plants also benefit from more efficient designs. The transplants have mastered the art of making gradual, minute, incremental labor-saving changes in production, the concept of "kaizen," which domestic manufacturers learned in the '80s to take seriously enough to introduce in their own plants. "We don't set out to double the output of our number two stamping line," explains a spokesman for Honda of America Manufacturing in Marysville, Ohio. "We look for only the next step. We shorten the time it takes to stamp our largest body panel by two seconds. And when we accomplish that, we shorten the time on the next largest panel, and then all the panels. And then we do the same thing on the next stamping line. When we've gone through the whole process, perhaps we've made the entire stamping plant 20 percent more efficient. But that wasn't our objective."

The age of factory employees will also affect transplant productivity in the '90s. The transplants have had three advantages in building their North American workforces. They have entered the market with no obligations to U.S. labor unions, which traditionally insist on certain employee-hiring procedures. They have used employment-application screening efforts to more carefully select workers based on physical and philosophical characteristics. And they have situated their facilities primarily in rural belts where applicants tend to have little history with either the automotive industry or manufacturing in general. The result has been a group of workers that are younger on average than those at Big 3 plants, who are slightly better educated, who have no predisposition to organized labor arrangements, and who — perhaps typical of younger workers — are more willing to cooperate with nontraditional labor practices, such as job rotation and accountability for production-line quality.

"When Detroit builds a new plant, they have to offer the jobs to laid-off UAW workers, who will probably be somewhat older and have their own ideas about the way plants are supposed to be run," says industry analyst Ronald A. Glantz, general partner with San Francisco's Montgomery Securities. "When a transplant opens a plant, it can go out and hire all 25-year-olds, prescreened to modern management and production techniques. The younger, more flexible workforce will simply be more productive."

It will also be less expensive. Because of their short history in the United States and the relative youth of their employee base, the transplants have no large pension and retirement expenses. GM alone supports almost 320,000 retired workers from its pension funds, more than 10 times the number of all the workers at all the transplants combined. In contrast to the new manufacturers, the average age of a GM worker is 43. Honda officials have countered that a young workforce has its unique overhead, too, including a higher incidence of family medical costs such as maternity benefits; aside from which the transplant must still pay into retirement funds for the distant time when its employees do retire. But the argument weakens under the weight of the numbers. GM's own healthcare bill topped $3 billion in 1989 — more than half Honda of America's total estimated revenues of $5 billion.

The '90s will see the "age gap" narrow between transplants and Big 3 labor forces. But it will still exist, and as long as it does, transplant overhead will be smaller and transplant operations more profitable.

One question remains about whether the transplants' young workers will maintain their enthusiasm indefinitely. The UAW union is moving slowly to bring the workforces into its fold during the '90s, and if successful, the raw productivity advantages could be lessened. So far, Honda, Nissan, Mazda and Mitsubishi have faced union organization drives in the States. Workers at Honda and Nissan decidedly rejected the union concept, while Mazda and Mitsubishi workers accepted it, largely because of pre-existing relationships with their Big 3 partners, Ford and Chrysler, respectively. By the early '90s, the union issue will also be posed at Toyota Motors' plant in Kentucky and Subaru-Isuzu Automotive in Indiana.

But by the end of the '80s, it appeared less likely that unionization would change the transplants than that the transplants would change unionization. The contracts that have been signed at Mazda, Mitsubishi's Diamond-Star Motors and Toyota's New United Motor Manufacturing in California, which was an existing union workforce when production began, indicate that union workers are willing to support the transplants' new management ways. In all three plants, workers have accepted limited job classifications, flexible work rules and job rotation. Issues of line speed and production changes are determined by committees that include line workers. Kaizen is in practice and productivity is still high.

The change may permeate the Big 3 in the 1990s. Saturn is already modeled after a transplant workforce. Chrysler's contract renewals in the early '90s are likely to be influenced by the innovative Diamond-Star contract of 1989. Ford will build minivans with Nissan in 1992 using some of Nissan's Japanese management practices, in addition to Nissan's cash. The odds are that if the 1990s are a showdown between old and new in the automotive industry, the manufacturing system that succeeds will be the one that appeals to the greatest number of people — whether in the factory or at the car dealership.

Toyota, the biggest of the Asian-based carmakers, has moved steadily but cautiously into its North American presence. It would be out of character for the global manufacturer to act otherwise in the coming decade. Toyota typifies the Japanese industry's habit of starting production with small, known quantities and gradually building up. New plants have tended to introduce modest levels of automation, by current standards, and to rely on more labor-intensive training to emphasize quality.

Still, by the close of the decade, the company had opened four American production lines, with plans for a fifth and speculation about additional capacity. U.S. company officials express interest in producing a full-size pickup somewhere in the States, probably near Toyota's $1.1 billion central Kentucky Camry complex. Toyota retailers in the States have pushed for a full-size vehicle to compete better in the lucrative pickup market. The entry would also give the company more power to penetrate its more elusive sales territories of the Midwest and the South.

Officials also acknowledge that the large new Kentucky plant could accommodate additional vehicles with minimal adjustment. While other new auto plants coming on line around the world have embraced a strategy of diversified, multi-vehicle production, Toyota's Camry plant produces only one vehicle. That plan is partially evidence of Toyota corporate conservatism, but probably not one that will be permanent. Toyota sales have rebounded from the downturn that followed the 1986 peak, and dealership outlets are slowly increasing. The market's appetite for product will clearly warrant more North American production over the next 10 years.

Toyota's involvement with GM in California will also have its benefits in the '90s. The working relationship has opened the door for many Toyota affiliate suppliers — who are hungry for Big 3 business — into GM's OE purchasing departments. And while GM has used the New Age environment at NUMMI to re-educate some of its management corps, Toyota has itself drawn valuable experience in managing a UAW workforce. Speculation has also hovered over the facility concerning GM's long-term plans. When the NUMMI agreement expires in 1996, one scenario has GM selling Toyota the other half of the operation. GM bows out of a plant it had originally closed anyway; Toyota picks up existing capacity for another 120,000 units a year.

Though Nissan experienced bouts of sluggish sales in the late '80s, it gave clear indications that its North American presence will continue to expand. In 1989, it embarked on a massive campaign to staff a new $50 million research and development operation in Farmington Hills, Mich., that company executives said will create new products specifically for the North American market.

The company entered the '90s with a number of obvious gaps in its U.S. production. It is now importing 110,000 Maximas a year from Japan, representing all but about 15,000 of the vehicle's total production. It is mulling over a plan to shift production of the sport-utility Pathfinder to Smyrna, which would mean another 50,000 units a year. And, like Toyota, it longed for a full-size pickup to counter Ford and Chevrolet. Unlike Toyota and Honda, however, it had no production in Canada, and faces coming to terms with creating and supplying local demand there during the '90s. The most logical move of the early '90s? A Maxima plant in Canada to supply Canada, the States and Japan.

At the same time, Nissan's relationship with Ford seems to be expanding. The two will co-produce a sport-utility vehicle in Spain in 1993, and possibly a sedan in Australia. What this suggests of the future relationship between Ford, Nissan and Ford-affiliate Mazda Motors remains to be seen.

The company also faces what the UAW called "a day of reckoning" with organized labor during the 1990s. Several industry analysts have chided the Smyrna management for "gloating" over the UAW's dismal showing at the company's first union election in 1989, when the UAW lost by more than a 2-to-1 margin. The union has vowed to return. If so, and if it should ultimately organize the transplant — a seemingly remote possibility at the close of the decade — company management will face an uphill climb in rebuilding the positive labor-management relations it now enjoys.

Though less than half the size of Toyota, Honda has moved more aggressively than any of the foreign car companies to establish a North American production base. Being the youngest of the major Japanese carmakers, Honda has depended, to a disproportionate extent, on the U.S. market for sales. As the '90s begin, the United States is importing more than a ▶

CHANGING SHARE OF U.S. MARKET
(figures in percent)

Company	1980	1985	1989	1994
General Motors	45.8	42.5	36.2	32.7
Ford	17.2	18.8	21.8	20.4
Chrysler	8.8	11.3	11.2	9.4
Honda	4.2	5.0	7.3	9.1
Toyota	6.5	5.6	6.2	7.6
Nissan	5.8	5.2	4.4	6.1

Sources:
Historical data: Motor Vehicle Manufacturers Association
1994 Predictions: J.D. Power & Associates

Japanese transplants take root

Supplier plants in U.S. will continue to have far-reaching effects

By any standard of measurement, Japanese transplants have enjoyed considerable success in the 1980s. Indeed, many in the American automotive industry have turned into Sinophiles: "If it's produced by the Japanese, either in the Orient or North America, then it must be good."

Domestic suppliers have been particularly hard hit by this blanket approval. A transplant which supplies Honda or Toyota often sees the welcome mat at the door when calling on Ford or Chrysler. And while Ford may claim that its Q1 suppliers are automatically qualified to do business with GM or Chrysler, an H1 or a T1 seems to put a transplant near the top of any domestic OEM's supplier class.

Some analysts are questioning the survival and ultimate success, i.e., the profitability, of the 300 plus Japanese transplant supplier plants, but few can deny that these new competitors represent a humbling experience for domestic suppliers as a whole. They have introduced new approaches to manufacturing, quality control and customer satisfaction which have shaken the foundations of the domestic supplier community.

Looking into the 1990s crystal ball first requires an examination of how transplants have affected their domestic brethren in the 1980s. The following list is by no means complete, and numerous articles have been written about each subject.

● Market Participation. Entering the North American automotive market has been the overwhelming concern of every transplant which has crossed the Pacific.

While profitability is a primary consideration of an American supplier contemplating such a significant move, satisfying their original equipment customers has been foremost in a transplant supplier's mind. Following original equipment manufacturers to the shores of America has had one benefit: The supplier has reasonable assurance that a contract is available if a plant can be built. This security has allowed the transplants to focus on a primary worry — learning how to do business in an alien culture. Not surprisingly, a large portion of transplants aggressively sought out U.S. joint-venture partners to help them become comfortable with government officials, construction companies, labor unions and the many organizations which must be dealt with to start a new business.

● Research, development and engineering. Initially RD&E was low on the list of transplants. Their first objective was to adapt manufacturing and assembly techniques proven in Japan to the American automotive environment. Manufacturing engineering has therefore received greatest attention. Japanese arrived to work with maintenance personnel and machine operators to teach new ideas. Close behind the manufacturing engineer is the engineer offering customer support.

● Manufacturing organization. Transplants have introduced more radical ideas here than in any other area. Just-in-time is the most noted, but perhaps not the most important example. Transplants are careful, even excessive planners. The objective is to get all parties to understand and buy into the plan, i.e., a pressurized consensus approach. One outgrowth is the phased implementation of production. Rather than cranking up as quickly as possible to projected production volume, transplants take considerable time to reach full capacity so that first-time quality is high when maximum line speeds are achieved. And because capital equipment is of the latest design, such new competitors are often tough to beat on cost.

● Labor. If domestic manufacturers learn only one thing from the transplants, it should be that production is an ever-changing process. Nowhere is this more evident than with regard to labor. Rather than management, capital and labor simply contributing to the final delivered product, transplants want each to interact with and improve the process. They have given a great deal of attention to labor's contribution to the production process, resulting in favorable lines of communication with management.

Transplants also realized the benefits of locating plants in smaller communities with more traditional American values and generally lower labor rates.

● Customers. In Japan, the customer is king. Japanese OEMs demonstrate this in their high concern with buyer satisfaction and the resulting dominance of the J.D. Power surveys. A transplant supplier's customer is the OEM, and he shows a similar fixation with satisfaction. An early example occurred when Chrysler agreed to let a transplant set up an office within its engineering complex with no guarantee that a contract would be forthcoming. The transplant engineers worked closely with their Chrysler counterparts and designed a product which matched the customer's precise needs. Today such investment is becoming standard procedure in developing long-term supplier relations.

Whatever we may be seeing in the transplants of the 1980s, it will certainly be different in the 1990s.

● Market Participation. Joint ventures have been the talk of the 1980s, but our Transplant Database suggests this will not be the case in the 1990s. The accompanying chart shows the portion of joint ventures by start-up year. With the exception of 1986, we have seen a steady increase in joint venture share. However, the 1990 share should decrease, and we expect this percentage to continue to fall. Indeed, buyouts may be the talk of the 1990s, as Federal Mogul, Borg-Warner, Wynn's International and others have already learned.

neering. The number of engineers is already growing faster than employee totals at transplant firms. While we do not expect the ratio of engineers to total employees at transplants to surpass that of domestic suppliers, it is very likely that transplants will become relatively stronger than competitors in customer engineering support.

In the area of new technologies, we see transplants already asserting themselves with the help of money. They continually seek out small technology firms needing funds for expansion, and they are actively courting university graduate research programs. Because government funding is lacking, Japanese firms will gain access to American R&D as a result of their deep pockets.

● Manufacturing organization. If we agree that the Japanese are obsessed with incremental improvement, the next step for transplants follows naturally. Once North America is no longer an alien business environment, the characteristics of production will become the foundation for building new manufacturing approaches in the 1990s. Adaptation and customization will be the theme for the next round of transplant openings.

● Labor. This has been an area of great success; however, transplants must prepare for a changing environment in the 1990s. The average transplant worker is young by automotive standards. If he or she were 30 when starting with Bellemar or Stanley Electric in 1982, then they will be nearing 50 at the end of the next decade. Health care and retirement will be their major concerns. These workers have demonstrated a long term commitment to their new employers by rejecting unions and dedicating themselves to new manufacturing methods. As the transplants' workforce ages, retirement, health care and other benefit costs will achieve a parity with that of domestic suppliers.

● Customers. While transplants will capture some domestic OEM business, they are beginning to realize that the high expectations of a few years ago may not pan out. If they are to survive the 1990s, the transplants will have to do it primarily based on contracts from their sisters. Over the past year, there has been a definite closing of the ranks among the domestic OEMs and their traditional suppliers. However, one battle ground remains: the aftermarket. Domestic companies such as Echlin and Standard Motor Product have been aggressively expanding their product lines to include foreign applications. Transplants are already preparing to capture their fair share of the independent replacement market for vehicles containing their parts.

So what is the bottom line on transplants in the 1990s? There will certainly be more of them, at least 350 supplier plants in total, and they will continue to make life difficult for their American competitors. But the U.S. economy is absorbent, and domestic suppliers are already adapting transplant techniques to their manufacturing lines.

Naturally there will be additional fallout on both sides. But when the dust settles in the 1990s, we expect to see many domestic suppliers holding up mirrors for the transplants to see some of their own transformed techniques. Such adaptation will make the automotive supplier environment just as competitive in the 1990s as it has been in the 1980s. ■

JAPANESE TRANSPLANT JOINT VENTURES
(portion of total start-ups by year)

Year	Percent of total
pre-1983	12
1983-84	23
1985	25
1986	50
1987	29
1988	45
1989	40
1990	35
1991	25

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third of Honda's entire Japanese output, and absorbing 400,000 American-built Hondas in addition. The company has stated its desire to design and build U.S.-specific vehicles in the States, and, like Nissan, is rapidly building up a U.S. design and engineering team for the mission.

To date, however, there have been no clear signals on what segment a new product might target. The company has no presence in the minivan, light-truck or sport-utility markets, and any new vehicle for them would likely be produced in the States.

Honda has targeted reaching an export volume of 70,000 U.S.-built units by 1991, or roughly 10 percent of its total North American output. Considering the plan to ship 50,000 units to Japan alone, indications are that future production could include a vehicle not produced in Japan.

The strong growth of Mitsubishi Motors in the '80s was led by its commercial vehicle division, although car exports have risen sharply in the last two years. Mitsubishi's ties to Chrysler and Hyundai both suggest that the future will see more joint venturing and mixed production in the States. The company is currently considering a North American engine plant, which could supply both Mitsubishi and Chrysler. Also reportedly under consideration is a Mitsubishi stamping plant in Canada to supply Chrysler's Bramalea, Ontario, Eagle division assembly plant, which could conceivably yield some Mitsubishi production. As Chrysler looks for other partnerships in the States to defray its cost of product development and plant construction, Mitsubishi will remain a key source.

The Mazda Flat Rock plant may serve as a vision of the future for some transplants in its symbiotic relationship with a domestic competitor. To overcome the enormous cost of starting a new plant, training a workforce and introducing new models to a still-fledgling market, Mazda, owned 25 percent by Ford Motor Co., sells a large share of its vehicle output to its Big 3 "parent." The captive arrangement gives Ford up to 120,000 Probes a year at lower costs than its average U.S. plant could maintain. And Mazda gains a large-capacity infrastructure which, if future demand warrants, could supply Mazda sales efforts.

The relationship will give Mazda, in return, approximately 9,600 Ford Bronco IIs from Ford's expanded Louisville Truck Plant in 1991. Mazda's assistance to Ford will also show up in Ford's U.S.-built 1991 Escort, which will be based on the Mazda 323 subcompact and carry a Mazda engine. It is worth speculating that Mazda could receive some additional U.S. production in exchange from Ford. At the same time, the company is perceived to be contemplating a new production site for more U.S. pickups.

Analysts have pointed to Fuji/Subaru as the least rooted and most vulnerable of the transplants, both because of the companies' smaller market share and because of the line's U.S. sales doldrums in the late '80s. But the introduction of the Legacy in 1989 indicated that Fuji would rekindle some market excitement in the '90s. Before the car was introduced, company officials were talking of Japan-based exports of the car to Europe, a first for the company, but an act that will increase the pressure on Indiana's success. Especially since Subaru of America anticipates selling as many as 80,000 Legacys a year and the plant will produce only 60,000. Nonetheless, Fuji is still contemplating exporting up to 12,000 Indiana Legacys a year to Taiwan in the early 1990s.

Isuzu's partnership with GM — which owns a 39-percent stake in the company — has probably helped Isuzu penetrate as far as it has in the States. The Japanese company has suffered from a weak balance sheet over the past decade, and its participation in Subaru-Isuzu Automotive is probably a signal that it is looking for new global opportunities. The company has discussed co-producing vehicles with GM's Adam Opel division in Europe, but what further U.S. opportunities it will find remain to be seen.

Suzuki appears to be rebounding from its sales catastrophe of 1987 when U.S. highway safety officials labeled the popular Samurai utility vehicle unsafe. A key to Suzuki's U.S. growth in the '90s will be its relationship with GM, which owns 4.8 percent of the company. The new CAMI joint venture is producing the Sidekick, and its GM equivalent, the Tracker.

The company is by no means in a strong global position, however. Financial institutions now essentially control the corporation, which suffered from undercapitalization in the late '80s. The company has shown some interest in improving its situation by marketing higher-priced vehicles, including some of GM's in Japan. Arguably, that strategy could lead to more U.S. production in the '90s if the pair co-develop a higher-end vehicle.

Many of the issues that govern what the Japanese transplants do in the '90s are not necessarily true for Hyundai. But the Korean carmaker is not immune to currency concerns of its own and the rising cost of Asian labor. The labor chaos of the late '80s sliced Korean output and exports during a crucial period. Workers struck across Korea to demand first an 18 percent wage increase and then a 27 percent increase. Increased production in North America may give the up-and-coming transplant more sales stability.

Initial production from Hyundai's $270 million Canadian plant is going to the Canadian market, except for a few thousand Sonatas which are being exported to Taiwan. But starting in 1990, the majority of the output will be shipped to the States. Some of the Sonatas will be sold to Chrysler for rebadging as a Jeep/Eagle vehicle. Look for an expanded tie with Chrysler in the '90s as the Big 3 partner ups its purchasing of captive production. ■

Tackling tomorrow's traffic today

U.S. looks for high-tech answers to future transit problems

There are 135 million passenger cars in the United States, one or every 1.2 licensed drivers. The utomobile has become a necessity nd a principal determinant of our festyle.

Because we depend so much on ars, it's frustrating when we occaonally discover that we can't get where we want to go.

The problem is traffic congestion congestion because of not nough pavement, accidents, conruction, rain, fog and road lockages of all types.

There are 110 million commuters the United States, double the umber in 1950. In 1986, 1.78 trilon miles were driven; and traffic ow was not just into town in the orning and out at night. It was in ll directions in, around, and cross town.

Over 61 percent of urban interate travel occurred under conested conditions (35 mph or less). here are two billion vehicle hours f delay per year attributed to conestion, and an estimated $73 illion loss to the nation because of ongestion and excess travel beause of poor navigation. Eliminaon of that loss for just two years ould have saved enough money to ave built the nation's entire interate highway system.

As if that isn't bad enough, it is timated that there will be a 400 ercent increase in delays by the ear 2000, and a larger fraction of e population will be involved.

Traffic congestion is often separated into two types — recurrent nd non-recurrent. Recurrent conestion is typified by the rush-hour affic or regular traffic jams round factories, office buildings nd shopping centers. A tunnel or ridge often produces recurrent e-ups. Non-recurrent congestion esults from accidents, construcon zones, stalled cars, special vents or inclement weather. It is timated that about 60 percent of e congestion delay in the U.S. is the non-recurrent type, while 40 ercent is recurrent.

There are several approaches to is problem.

aying more pavement would help, especially where congeson is recurrent. However, the inerstate highway system is about omplete and the public has beome concerned about taking up ore space with pavement and the igh cost of highway construction urban areas.

Mass transit also has a role to lay where large numbers of peole travel in specific corridors. owever, doubling mass transit ould only handle a few percent of e problem. And, the American ublic has demonstrated over and ver that it prefers the flexibility, rivacy and independence of the utomobile over mass transit.

Recently, interest has shifted to n Intelligent Vehicle/Highway ystem. Some call it "The Cooperative Highway." It's a way to balnce traffic densities throughout n urban area and give drivers hough up-to-date information at they can make the proper deisions about where to drive to void congestion and reduce asteful miles.

One might think of this system as a grand extension of the highway traffic advisory system based on helicopters and commercial radio used today. This system will do that job much better, and much more besides.

The Intelligent Vehicle/Highway System basically consists of four parts: a navigation system on the vehicle, a traffic control center for the urban area, two-way communication between the vehicle and the traffic control center, and sensors on the highway to detect traffic densities and vehicle speeds.

Navigation systems have been developed in several configurations. One effective system displays information, such as an electronic map, on a TV-like screen in the instrument panel. A marker continuously indicates the car's immediate location. It is possible with a navigator to type in a destination, and have it indicated on the map with an arrow pointing from the car's location to the destination. In addition, you get a readout of the distance to the destination. You can buy one for your car right now.

Traffic control centers already exist in a number of urban areas. Today, highway sensors on the Santa Monica Freeway send signals to the Los Angeles Center which allow the center to adjust freeway ramp gates. In the future, the center also would receive information from individual vehicles and adjust traffic signals, signs and ramp gates to balance traffic densities over the entire street/highway system — in real time. The center also would advise drivers of congested areas, weather, accidents or any other blockage and suggest alternate routes to avoid them.

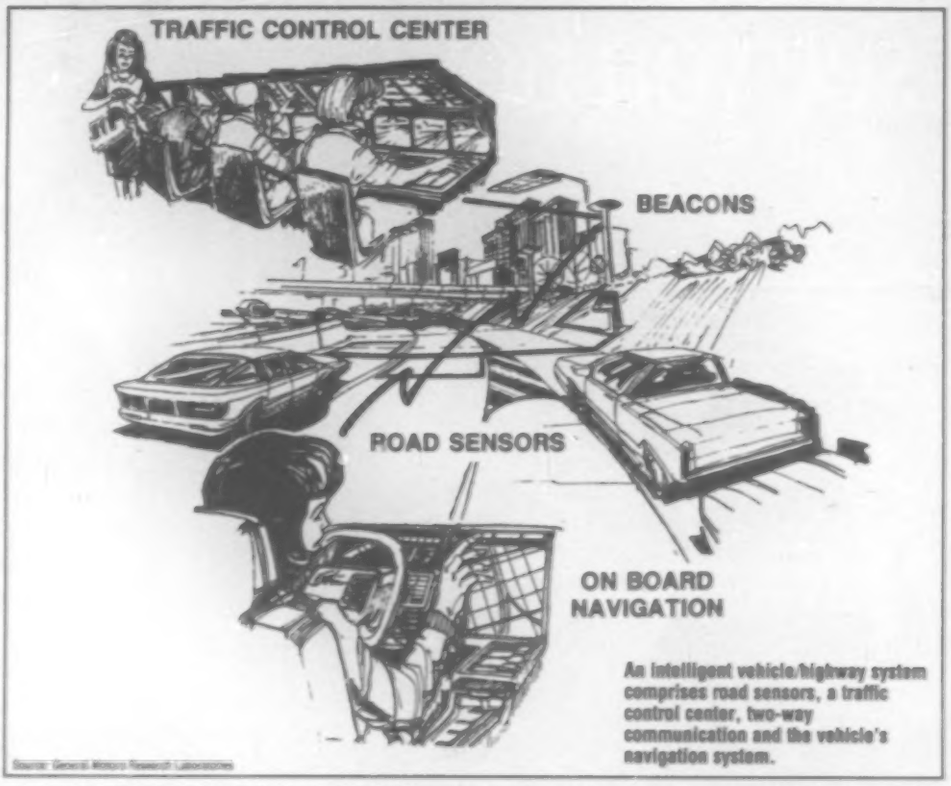
Once the two-way communication system is installed, the variety of information that could be supplied is considerable. We could provide information on the location of parking lots, police and service stations. A Mayday system could alert police or EMS units to accidents. Automatic toll collection could help reduce traffic backups. You could even supply an electronic version of the yellow pages to provide, say, restaurant locations, their menus and prices.

You may already have heard of Project Pathfinder. In this three-year experiment to be conducted in the Santa Monica SMART Corridor, cars equipped with a navigator and a two-way communication system will be connected to the Caltrans Traffic Operations Center. General Motors is providing 25 Oldsmobile cars to test, and they will be equipped with Etak Navigators. The project is jointly supported by the California Department of Transportation, the Federal Highway Administration, and General Motors. The purpose will be to determine the benefits realized by the driver and overall costs. This is a small test. Outside the U.S., tests on a much larger scale are being conducted.

In Europe, there is the PROMETHEUS Project. Its participants include: 14 auto companies (with the U.S. and Japanese excluded); over 70 other computer, electronic and telemetering companies and institutes; and five governments. The project is budgeted at $750 million and is planned to last 8 years. Large-scale experiments are already under way in London and Berlin. Similar programs are under way in Japan. Experiments with the AMTICS program began in 1988 in Tokyo. Another Japanese program, called the Intelligent Vehicle System, is priced at $700 million.

I mention these overseas programs to indicate that this concept is real and being pursued vigorously in other countries. In the U.S. there are a few small-scale activities under way, but the problem is king-sized, and what is needed is a truly national initiative.

What is most needed are demonstration experiments, like the Pathfinder Project, of different aspects of the concept under a variety of urban conditions. We need to find out which technology will give us the most benefit with the least cost. We also need additional research on traffic theory to develop the expert systems for use in the traffic control centers. And finally, it would make a lot of sense if we combined our efforts with the Europeans and Japanese to proceed as quickly as possible. ■



An intelligent vehicle/highway system comprises road sensors, a traffic control center, two-way communication and the vehicle's navigation system.

Source: General Motors Research Laboratories

Author Dr. William Agnew is Director of Programs and Plans at General Motors Research Laboratories.

Improving the flow of traffic

Increase predicted in sales of signs, signals and road markers

Signals, signs and pavement markings improve traffic flow, help avoid damage to motor vehicles and roadside properties and prevent injuries and fatalities.

Those products are selected and purchased by officials in a wide variety of appointed positions in city, county and state governments.

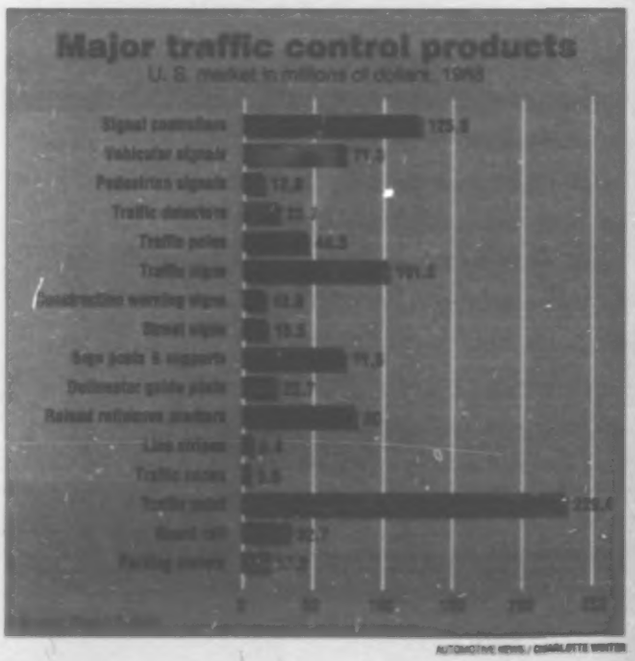
The decision-making processes vary widely among those end users. Growth in regional traffic volume is directly related to population growth and to socio-economic trends like the increase in wage earners per household.

A report by Frost & Sullivan, a New York market research firm, says the overall market for those products should increase 3 percent annually through 1993. Among those products, signal controllers will remain high in dollar sales and are expected to exhibit a high percentage of growth. Sales totaled $125.8 million in 1988, and are expected to jump to $149.2 million in 1993. (All figures are in constant U.S. dollars.)

Unit sales are expected to increase from 21,440 in 1988 to 26,650 in 1993. The greatest increases are expected in cities with populations of 5,000 to 9,000 and counties of 25,000 to 49,000.

By geographical areas, the Mountain region will reflect the largest increase in unit purchase volume by both city/county and state governments, with an overall increase of 53.1 percent during the five-year period. The largest volume of sales will continue to be in the South Atlantic region, with 5,750 units sold in 1988 and 6,485 forecast for 1993.

The largest dollar sales by product are paint for traffic lanes, signal controllers and traffic signs. Sales of traffic paint were $229.4 million in 1988, and sales of $237.9 million are forecast for 1993.



AUTOMOTIVE NEWS / CHARLOTTE WHITE

Sales of traffic signs totaled $101.9 million in 1988 and are projected at $116.4 million in 1993.

Frost & Sullivan said traffic signs lead in unit sales; 4.2 million were sold in 1988 and 4.8 million are expected to be sold in 1993. Other high-unit-sale items include raised reflective markers, signposts and supports. ■